

Technical Report 621

Armor Procedural Skills: Learning and Retention

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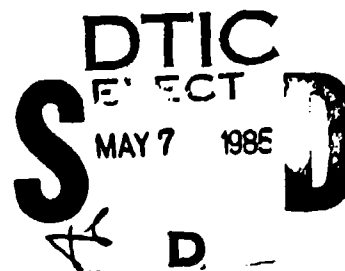


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out of OSUT entry training for up to 72 months. ~~Soldiers in the OSUT sample participated in a series of task learning trials for two tasks followed by a retention trial approximately four weeks later.~~ The operational unit soldiers took a one-time performance test on all eight tasks. Results were consistent with previous skill retention research. Multiple regression analysis was used to predict the slopes of the retention function for each task for the combined sample. ~~The prediction equation accounted for a large proportion of the variance when number of steps in the task, daily practice rate, and measures of complexity and interference are used as predictors of skill decay rate.~~ The results of the OSUT, unit, and combined samples support a representation of the skill retention curve in which rapid decay occurs soon after training with little change in performance for samples tested later. *Key needed*

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FOREWORD

Modern armor weapon systems require soldiers to learn, retain, and be able to perform a large number of frequently complicated procedural tasks. The Army Research Institute at Fort Knox has undertaken research to improve methods for training those tasks and to estimate the requirements for training them in operational armor units.

Procedural tasks are performed in preparing tanks for operations and during combat. Their correct performance prevents unnecessary damage to equipment and helps to ensure success in combat. The present research involves a number of tasks that are initially taught in One Station Unit Training (OSUT) at the Armor Center and then performed and trained intermittently in Armor units. The purpose of the research reported here is to provide a data base showing the acquisition and retention of armor procedural skills. The data base will be used to build models of skill learning and retention that can be useful in management of training and to replicate the findings of earlier skill retention research, which demonstrated the importance of a number of variables in predicting performance over time.

The results of this project feed into a body of research in skill retention performed by the Army Research Institute. The research has implications for training designers in Army schools and for training managers in units.



EDGAR M. JOHNSON
Technical Director

ARMOR PROCEDURAL SKILLS: LEARNING AND RETENTION

EXECUTIVE SUMMARY

Requirement:

Soldiers' performance of armor procedural skills is a complex mixture of training experiences, task characteristics, individual abilities, and on-the-job performance history. The present research was performed to establish a data base for retention modeling and to replicate previous findings that identified factors affecting skill learning and retention.

Procedure:

A subset of eight armor procedural tasks trained during One Station Unit Training (OSUT) were selected to represent tasks that vary in length, complexity, and extent of practice in operational unit. Data collections were conducted using soldiers in operational armor units and soldiers attending OSUT. The operational unit sample had all completed OSUT within 72 months prior to the study. The operational unit data collection consisted of soldiers performing the eight tasks in a "round robin" fashion. Each soldier's performance was scored. If soldiers made errors, they were given varying levels of prompts sufficient to allow them to continue and eventually complete performance of the task. The OSUT data collection involved training and retention testing of soldiers who had received formal training on tasks prior to participating in the research. Each soldier performed two of the eight tasks. For each task tested, the soldier reported twice to the test site. In the first session, soldiers performed a task five times, using the same prompting procedure described above. Approximately 4 weeks after the first session, soldiers returned to perform the task one additional time.

Findings:

The percentage of task steps performed correctly was used as the primary dependent measure because none of the soldiers in the operational unit sample correctly performed three of the tasks. There were no significant correlations in the operational unit sample between task performance and months since graduation from OSUT, months since last Table VIII, or education level. For the OSUT sample, learning over the first five trials was charted as was retention between the fifth trial and the sixth trial administered 4 weeks later. The effect of learning was significant for all trials and results of analysis of variance found a significant decrease in performance for all tasks except ground guiding between trials five and six. Both the proportion of soldiers and the average percentage of steps performed correctly returned to approximately the level of the second learning trial after the retention interval. Combining the samples and using multiple regression techniques to predict the slope of the retention functions for each

task produced an equation that accounts for 94% of the variance when number of steps in the task, daily practice rate, and measures of complexity and interference are used as predictors. The results of the OSJT, unit, and combined samples support a representation of the skill retention curve in which rapid decay occurs soon after training, with little change in performance for samples tested later.

Utilization of Findings:

The results of the analysis indicated some ability to predict differences among tasks in the rate of forgetting from the number of task steps, and details about practice on the task. These findings were also consistent with earlier research that utilized similar data collection techniques. Results of the combined analysis indicate that differences in performance practices between the training standard and unit methods will result in apparent decline in performance even under conditions of frequent practice. Data collected here will be utilized in development of a model for skill learning and retention.

ARMOR PROCEDURAL SKILLS: LEARNING AND RETENTION

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ARMOR PROCEDURAL SKILLS: LEARNING AND RETENTION

INTRODUCTION

A critical issue in planning military training is estimating the requirements for initial and refresher training. For example, certain tasks that are difficult to learn or are performed infrequently require additional initial training and periodic retraining. The frequency of refresher training, then, depends on the amount of skill retention, the costs of training, and the minimum level of proficiency required for mission accomplishment.

Over 100 years of research and theoretical development indicates that skill retention depends on the level of original learning and other training considerations, individual differences, task variables, retention interval variables, and transfer among tasks. These factors have been analyzed in several comprehensive reviews that are summarized in Table 1. The reviews differ in the kinds of skills examined, research settings, focus, and time span covered. The most recent review, by Rose, McLaughlin, Felker, and Hagman (in preparation), integrated research by or for the U.S. Army Research Institute (ARI). The kinds of skills and variables in the ARI studies are the most relevant to the present research and therefore are emphasized in the following discussion of skill acquisition and retention.

Level of Original Learning and Other Training Considerations

The level of original learning is perhaps the most potent factor of determining the level of performance after periods without practice. Block and Burns (1976) analyzed 27 skill retention experiments and determined that training to a mastery level (rather than to a minimum level of skill) produced significantly more retention in 17 of the experiments and nominally (but not significantly) more in 9 other experiments.

ARI research shows that training beyond the typical Army criterion of one correct performance of the task improves retention (Goldberg, Drillings, & Dressel, 1982; Hagman, 1980b; Schendel & Hagman, 1980; Shields, Joyce, & VanWert, 1979). However, Rose et al. (in preparation) pose the following questions: How much initial training must be given? Is it cost effective? Under what conditions is it superior to refresher training? The answers appear to depend on such factors as the time available for refresher training versus the costs of initial mastery training, but definitive research has yet to be conducted.

Other factors that influence skill retention are the extent of active practice, spaced practice, and transfer of training among task clusters. Performance tests and active practice produce higher rates of skill retention than passive presentation of the material (Hagman, 1980a; Hagman, in preparation; Holmgren, Hilligoss, Swezey, & Eakins, 1979). Repetitions of the task, spaced a day apart, produce high retention even when the soldiers have to learn other tasks between repetitions of the tested tasks (Hagman, 1980c). However, spacing the repetitions 4 weeks apart does not enhance retention (Schendel & Hagman, 1980).

Table 1

Skills Retention Literature Review

| Review | Time Span | Setting | Characteristics | |
|---|-----------|---------------------------------|---------------------------------------|--|
| | | | Behavior Examined | Focus |
| Naylor & Briggs (1961) | 1960s | Academic | Mostly verbal | Military, U.S. Air Force |
| Gardlin & Sitterley (1972) | 1960s | Military | Simulation, Essential Element, Verbal | Simulators, Long-term Retention Spacecraft skills. NASA |
| Prophet (1976) | 1960-1976 | Academic & Military | Psychomotor | Long-term flight skills or complex performance |
| Wheaton, Rose, Fingerman, Korotkin, Holding, & Mirabella (1976) | 1950-1976 | Academic & Military | Verbal & Psychomotor | Initial training, Transfer of training, Device effectiveness |
| Annett (1977) | 1885-1976 | Industrial, Military & Academic | Psychomotor & Perceptual | Skill loss, areas for further research |
| Johnson (1978) | 1860-1977 | Academic | Verbal | Retention/Transfer on procedural task; cognitive style |
| Schindel, Shields, & Katz (1978) | 1960-1977 | Academic | Psychomotor | Retention over lengthy no practice intervals |
| Koerr, Berger, & Popelka (1980) | 1960-1977 | Military | Psychomotor & Communications | Sustainment of team/crew performance |
| Rose, McLaughlin, Felker, & Hagan (in press) | 1975-1981 | Army | Psychomotor | Research by and for the U.S. Army Research Institute |

Individual Differences

Aptitude differences influence skill acquisition and thus indirectly influence retention. Army research demonstrates the favorable effects of general aptitude on skills in Air Defense and Field Artillery (Department of the Army, Training and Doctrine Command [TRADOC] Systems Analysis Activity [TRASANA], 1977; U.S. Army Field Artillery School, 1977). Rose et al. (in preparation) note, however, that Army research on the subject, as yet, is inconclusive.

Five ARI projects investigated the effects on skill retention of individual ability as measured by Army aptitude tests. Vineberg (1975) found a direct relationship between aptitude and performance on both initial and retention tests; however, the relationship did not hold for all tasks. Other ARI research discovered no significant relationship between aptitude and performance (Goldberg et al., 1982). Any relationship may be mediated by training methods (Dressel, 1980; Holmgren et al., 1979; Sullivan, Casey, & Hebin, 1978).

Task Variables

Schendel, Shields, and Katz (1978) succinctly state that "Procedural tasks and individual discrete motor responses are forgotten over retention intervals measured in terms of days, weeks, or months, whereas continuous movements typically show little or no forgetting over retention intervals measured in terms of months or years" (p. 5). The cognitive mechanism producing differences in retention of procedural and continuous tasks may be the extent of memorization, which is greater in procedural tasks. Most Army tasks, however, are procedural, and thus the global distinctions used to characterize tasks fail to distinguish the determinants of retention.

The differentiation of tasks into their components, skills, steps, or sub-tasks leads to the detailed behavioral analysis of tasks to determine their stimuli, processes, and responses. These components, or subtasks, differ in their level of retention, as shown in existing research. Rose et al. (in preparation) summarize the types of tasks that have been examined in Army skill retention research, and note that descriptive analyses of the tasks and steps have been performed post hoc. Dimensions of task steps and tasks that appear to reduce retention, and documents reporting this information include the following:

1. Difficulty or high skill demand
Goldberg et al. (1982)
Osborn, Campbell, and Harris (1979)
McCluskey, Hiller, Bloom, and Whitmarsh (1978)
Vineberg (1975)
Hagman (1980b & c)
2. Lack of cues from sequential steps, equipment, etc. (often the safety precautions)
Goldberg et al. (1982)
McCluskey et al. (1978)
Osborn et al. (1979)
Shields, Goldberg, and Dressel (1979)

3. Unclear to the soldier or of questionable relevance to the task
Osborn et al. (1979)
Shields, Goldberg, and Dressel (1979)
4. Task boundaries (first and last steps)
Osborn et al. (1979)
5. Passive steps
Osborn et al. (1979)
6. Training and testing differences
Goldberg et al. (1982)
Osborn et al. (1979)

Shields, Goldberg, and Dressel (1979) also demonstrated that longer tasks (more steps) and tasks that contained multiple subtasks were forgotten sooner than others.

Retention Interval and Differences Between School and Operational Unit

Job activities during the retention interval complicate the relationships among training, tasks, and individual variables. Performance decrements are likely after the no-practice period when soldiers transfer from school to their unit assignments. Afterward, tasks that receive on-the-job practice show increments rather than decrements in performance (TRASANA, 1977). Tasks specific to the job are practiced during normal duties while common tasks (e.g., first aid) are practiced infrequently during early months in the unit and are not retained as well. Common tasks are not retained as well as job-specific ones even if the soldiers are not assigned to a duty position for which they were trained (Osborn et al., 1979). Therefore, practice on the job does not completely explain the retention differences.

A problem in the skill retention literature is in reconciling differences in the way soldiers are taught to perform tasks in the training center (the by-the-book approach) with the way they perform the same tasks in operational units. Somewhere along the way, soldiers learn to take shortcuts, such that by the time they are tested for skill retention in their units they are no longer defining tasks the same way as the researcher, who is following the school-taught procedure. Skill retention may look poor because of these differences. Soldiers can functionally perform the task, although not by the Army-prescribed procedure. Evidence of this fact can be found in the systematic errors soldiers made in a study where safety procedures were consistently not retained (Shields, Goldberg, & Dressel, 1979).

Objectives

The effects of aptitude, task types, and initial learning on skill retention suggest the need to tailor training to enhance skill retention. If the effects, singly or in concert, were known they could be used to guide training management. For example, Rose et al. (in preparation) envision a "task performance book" for troop commanders to estimate proficiency and

training needs by task type. Recent empirical field research has investigated skill retention in several Army Military Occupational Specialties (MOS); however, the empirical research is extremely expensive, even for a few skill retention variables. The high cost of field research does not allow for empirical tests of the effects of training strategies on acquisition and retention of Army skills.

Analytical models of skill acquisition and retention offer a potential solution to training management problems. Models organize large quantities of data from empirical studies to predict the effectiveness of various training strategies. A validated model can go beyond empirical results to answer training management questions for soldiering tasks for which no data exist.

This report is part of a larger project to develop and validate mathematical models of skill acquisition and performance of procedural tasks. The objectives of the report are to present the data collected as the basis for model development, and to analyze those data to replicate previous skill retention results. In particular, the data collection method was similar to that used by Shields, Goldberg, and Dressel (1979).

METHOD

Task Selection

The population of tasks included all tasks performed in the driver, gunner, and loader positions in the M60A1 tank. These tasks vary in length, complexity, and extent of practice in the unit after initial training (One Station Unit Training [OSUT]). The following eight tasks were selected from the task population to represent high and low values on these dimensions:

1. Load an M240 Machinegun,
2. Start the M60A1 Tank Engine,
3. Stop the M60A1 Tank Engine,
4. Perform Gunner's Prepare-to-Fire Checks,
5. Perform Loader's Prepare-to-Fire Checks,
6. Engage Targets Using Precision Fire Techniques,
7. Communicate over Tactical FM Radio, and
8. Communicate Using Visual Signal Techniques.

The selection of tasks was based on a preliminary analysis of the task population. The actual length, complexity, and extent of practice were determined by behavioral analysis and analysis of questionnaire data.

Behavioral Analysis

The tasks were analyzed to determine the task elements (steps), standards, and conditions of performance. These analyses were used to develop test scenarios and score forms.

Additional behavioral analyses of the tasks covered characteristics related to learning, performance, and retention gleaned from the literature and previous research. Characteristics include subtask sequence (task elements,

connections, branches, and dependencies); cues for task element performance from the equipment, fellow crew members, etc.; products of tasks and task elements; and task characteristics related to skill acquisition and retention (feedback and interference). Project staff and noncommissioned officer (NCO) personnel who served as scorers in the data collection rated each task element on the following 14 characteristics:

1. Requires recall of knowledge,
2. Requires rule learning and using,
3. Requires guiding and steering, continuous movement,
4. Lacks cues,
5. Has stimulus-response conflict,
6. Has aversive consequences,
7. Has feedback,
8. Unit omits the step (interference),
9. Unit performs the step differently (interference),
10. Unit performs different step (interference),
11. Step not performed in similar task (interference),
12. Step not performed in emergency or in combat (interference),
13. Difficult, and
14. Critical to the overall performance of the task.

The project staff prepared the test protocols, scorer training materials, and behavioral characteristic rating forms, and conducted data analysis in an operational unit and in Armor OSUT, both located at Fort Knox, Kentucky.

Operational Unit Data Collection

Subjects. Subjects were 120 soldiers from operational units of Fort Knox, Kentucky, who had completed the OSUT program within 72 months prior to the study. Four soldiers who graduated before 1979 were eliminated from the sample since they were beyond the target population for the research. The results, therefore, reflect the performance of the remaining 116 soldiers, who completed the OSUT program within 31 months prior to the study.

Procedure. Soldiers from the operational unit were randomly assigned to one of eight test stations. Each soldier proceeded in a "round robin" fashion to the next station until he or she had performed all of the eight tasks. At each test station, the soldier was given one opportunity to perform a task. The scorer read a set of instructions to inform the soldiers of the task and any specific conditions to consider during performance (e.g., moving or stationary targets during precision fire engagements). After reading the instructions, the scorer did not intervene during the performance of the task unless the soldier made an error.

If the soldier committed an error on a step, the scorer gave some assistance. If this degree of assistance was not sufficient to produce correct performance, the scorer gave stronger assistance, until correct performance was obtained. The following three levels of assistance were used:

- Level 1** - Remind the soldier what the overall task is and tell him or her the steps performed up to that point.

Level 2 - Tell the soldier what the next step is.

Level 3 - Show the soldier how to do the step.

After demonstrating the step correctly, the soldier proceeded to the next step and continued until the task was completed.

While the soldier performed the task, the scorer recorded data on correct performance of task steps, the order in which the soldier performed the steps, the type of error committed, the level of assistance given, and the elapsed time. Questionnaires were used to collect information on each soldier's background and task-related job experience. Armed Service Vocational Aptitude Battery (ASVAB) scores and level of education were obtained from personnel records.

OSUT Data Collection

Subjects. Subjects were 471 soldiers from four OSUT companies at Fort Knox, Kentucky, in their fifth to tenth week of training.

Procedure. Testing and training trials included five acquisition trials and a retention trial, for a total of six performances by the soldier. Each soldier performed two of the eight tasks. For each task tested, the soldiers reported to the test site twice during a 12-week data collection period. In the first session, the soldier performed the task five times using the procedure described for the operational unit. Approximately 4 weeks after the first session, the soldier returned to perform the task one time. The first session coincided roughly with formal training of the task; the second session coincided roughly with the gate test for that task.

Minor changes were made in the scoresheets between the operational unit and OSUT sessions to simplify the data collection procedure or to accommodate changes in the Army's training policies. In order to ensure comparability of scores, only those performance measures common to both scoresheets were considered in measuring performance.

RESULTS

Sample Demographics

Description of the Operational Unit Sample. The soldiers had pay grades ranging from 1 to 5 with the following percentages: E-1, 6.0%; E-2, 27.6%; E-3, 34.5%; E-4, 31.0%; and E-5, 0.9%. Almost all of the soldiers in the operational unit sample had completed OSUT in 1980 or 1981 so that they were within 2 years of graduation (Figure 1).

In OSUT, approximately half of the soldiers had been in each of the Armor tracks. Until January 1982, soldiers in Armor OSUT were enrolled as either MOS 19E gunner/loader or MOS 19F driver. Since then, there has been only one basic Armor training course (19E) training a general Armor crewmember. Over 48% of the research sample had been in the driver track, and over 50% had been

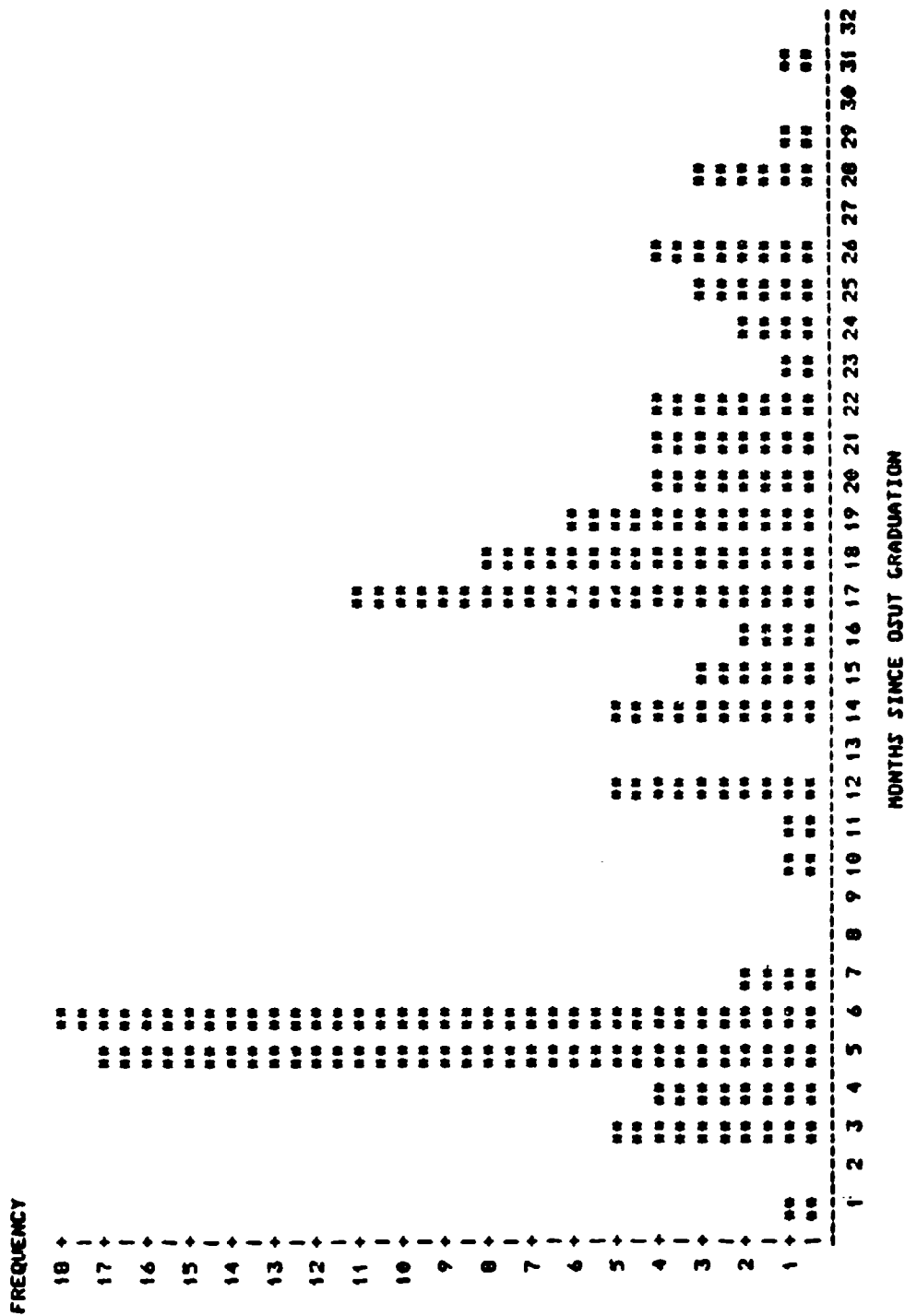


Figure 1. Distribution of number of months since OSUT graduation for operational unit sample.

in the gunner and loader track during their OSUT training. (The one remaining soldier graduated in 1982 when OSUT had no tracks.)

In their assigned posts, the soldiers held tank crew or truck driver positions, and the majority (58.8%) had the position for which they were trained in OSUT. Half had held their current duty position less than 8 months. Three-fifths of the soldiers had participated in Table VIII gunnery exercises.

Armed Forces Qualification Test (AFQT) and ASVAB results for the operational unit soldiers are shown in Table 2. The scores are similar to, but slightly lower than, the standardization population means of 50 for the AFQT and 100 for the ASVAB composites. The AFQT distribution by mental category is shown in Table 3. Approximately half of the soldiers were in category III, which contrasts with Goldberg et al. (1982) where 78.1% of the sample were in category III.

Table 2

ASVAB Results

| ASVAB components | Operational unit sample ^a | | OSUT sample ^b | |
|-----------------------------|--------------------------------------|--------------------|--------------------------|--------------------|
| | Mean | Standard deviation | Mean | Standard deviation |
| AFQT | 44.06 | 23.11 | 54.69 | 18.60 |
| Combat | 98.67 | 16.18 | 105.88 | 12.88 |
| Field Artillery | 97.47 | 15.92 | 104.06 | 12.97 |
| Mechanical Maintenance | 98.37 | 17.79 | 105.62 | 13.01 |
| General Maintenance | 96.10 | 16.33 | 104.06 | 14.71 |
| Clerical | 95.28 | 16.01 | 100.95 | 13.03 |
| General Technical | 96.31 | 16.76 | 105.14 | 12.43 |
| Electronics Repair | 98.21 | 14.96 | 103.81 | 13.01 |
| Surveillance/Communications | 96.39 | 15.54 | 103.01 | 12.90 |
| Skilled Technical | 97.14 | 15.18 | 102.65 | 13.66 |
| Operators and Food Handlers | 95.70 | 19.41 | 103.54 | 12.69 |

Note: All group differences are significant by a t-test, $p < .001$.

^aN = 107.

^bN = 370.

Description of the OSUT Sample. ASVAB scores were available for 370 of 471 subjects in the OSUT sample. The AFQT and ASVAB composite results for the OSUT soldiers (shown in Table 2) indicate that soldiers' scores were higher than the standard means on all but one of the composites (Clerical) and were significantly higher than operational unit scores on the AFQT and all of the ASVAB composites. The difference may be attributable to an increase in the

enlistment standards between the time of entry of the soldiers in the two samples. The distribution of OSUT soldiers by mental category is shown in Table 4.

Table 3

Mental Category Distribution in Operational Unit

| Mental category | Soldiers in unit sample | |
|-----------------|-------------------------|---------|
| | Number | Percent |
| I | 3 | 2.7 |
| II | 24 | 21.4 |
| III | 49 | 43.8 |
| IV | 36 | 32.1 |

Table 4

Mental Category Distribution in OSUT Sample

| Mental category | Soldiers in OSUT sample | |
|-----------------|-------------------------|---------|
| | Number | Percent |
| I | 11 | 3.0 |
| II | 93 | 25.1 |
| III | 232 | 62.7 |
| IV | 34 | 9.2 |

Most of the OSUT soldiers were in the lowest Army grade, although a few had previous service, and therefore had higher grades, as follows: E-1, 86.8%; E-2, 4.7%; E-3, 6.6%; E-4, 1.7%; E-6, 0.2%.

Task Characteristics

The behavior analyses included the rating of individual task elements on 14 attributes. Ten of these attributes were used to define indices of task complexity and task interference. Components of these two indices are as follows:

- Interference

Unit omits the step
 Unit performs step differently
 Unit performs different step
 Step not performed in similar tasks
 Step not performed in emergency or in combat

- Complexity

Requires recall of knowledge
 Requires rule learning and using
 Lacks cues
 Has stimulus-response conflict
 Very difficult to perform

The indices combined scores on items scaled from 0 to 10, with items scored as proportions between 0 to 1. To make the ranges of these different types of items comparable, the items scored as proportions were multiplied by 10. The limits of the interference and complexity indices are -10 and 40.

Table 5 summarizes the task characteristics believed to be related to skill retention. Means over tasks for the complexity index varied from approximately 1 for Load Machinegun to over 10 for Ground Guiding; the interference index ranged from -7.88 for Load Machinegun to 2.94 for Stop the Tank Engine.

Table 5

Summary of Task Characteristics

| Task | Steps | Complexity index | | Interference index | |
|------------------------------|-------|------------------|----------|--------------------|----------|
| | | Mean | St. dev. | Mean | St. dev. |
| Load Machinegun | 11 | 1.41 | 4.38 | -7.88 | 2.85 |
| Start Tank Engine | 11 | 4.27 | 2.98 | -0.22 | 5.54 |
| Stop Tank Engine | 10 | 4.20 | 4.61 | 2.94 | 7.58 |
| Gunner Prepare to Fire | 34 | 4.80 | 2.59 | -4.47 | 1.38 |
| Loader Prepare to Fire | 6 | 3.54 | 0.87 | -5.96 | 5.54 |
| Precision Fire | 12 | 5.29 | 7.94 | -6.25 | 0.72 |
| Radio Communication | 7 | 1.86 | 3.04 | -4.95 | 5.07 |
| Ground Guiding | 20 | 10.15 | 0.49 | -6.68 | 2.52 |
| Index results over all tasks | | 5.11 | 4.26 | -4.33 | 4.79 |

Task Experience

Task Experience in the Operational Unit Sample. The proportion of soldiers who report practicing the tasks since graduating from OSUT ranged from 37.5% (Precision Fire) to 95.5% (Ground Guiding). The three tasks reported to have over 90% of the soldiers practicing (Ground Guiding, Start Tank, and Stop Tank) also had large numbers of soldiers reporting practice more than one time per day, as well as high average practice per day, as indicated in Table 6. Since all of these tasks are trained in Armor OSUT, the date of graduation from OSUT was assumed to be the time of last practice for all soldiers who reported no practice for a particular task in the unit.

Table 6

Task Experience per Day in the Operational Unit

| Task | N | Task experience | | | | Average per day |
|------------------------|-----|-----------------|----|----|----|--------------------|
| | | Times each day | | | | |
| | | 0 | <1 | 1 | >1 | |
| Load Machinegun | 114 | 42 | 69 | 2 | 1 | 0.07 |
| Start Tank Engine | 110 | 7 | 26 | 26 | 51 | 1.80 |
| Stop Tank Engine | 108 | 7 | 27 | 25 | 49 | 1.79 |
| Gunner Prepare to Fire | 113 | 49 | 62 | 0 | 2 | 0.08 |
| Loader Prepare to Fire | 109 | 45 | 62 | 0 | 2 | 0.08 |
| Precision Fire | 109 | 70 | 38 | 0 | 1 | 0.03 |
| Radio Communication | 110 | 19 | 81 | 3 | 7 | 0.37 |
| Ground Guiding | 107 | 5 | 35 | 28 | 39 | 1.98 |

Task Experience in the OSUT Sample. Soldiers in the OSUT sample had just completed their initial training on the tasks when the pretest was administered for the research. The retention test for a task was timed to coincide approximately with the gate test following training in that task.

Task Performance

Soldiers in the operational unit were tested once, while soldiers in OSUT were tested six times (five acquisition trials and a retention test). No soldier in the operational unit achieved perfect performance on three of the tasks; therefore, the percentage of soldiers correctly performing the entire task had no variance for those tasks, and could not be used as a dependent variable. The number and percentage of task steps performed correctly were used as dependent measures of performance.

Task Performance in the Operational Unit Sample. The task with the highest average percentage correct (99%) was Ground Guiding, which has high levels of practice in the unit. It is a long task, as tested, but each visual signal

in the task is short (two or three steps), and thus easy to remember. Some of the signals occurred more than once in the tests; these were removed before the scores were analyzed so that the results reflect data for testing each signal one time only.

Three other tasks--Load Machinegun, Stop Tank Engine, and Radio Communication--averaged over 70% of the steps performed correctly. All three tasks are short and have high or moderate levels of practice in the unit. Load Machinegun and Radio Communication are relatively simple tasks, but Stop Tank Engine has moderate complexity.

The lowest scores occurred on the Gunner Prepare to Fire task, which is long, complex, and has low practice in the unit. Scores on the remaining tasks (Table 7) averaged from 52% (Loader Prepare to Fire) to 67% (Start Tank Engine). Scores on task steps are reported in Appendix B.

Correlations between the number of correct task steps and demographic variables were examined. For one task, Load the Machinegun, task performance correlated significantly with the number of months since last practice ($r = .20$, $p < .05$, $N = 113$). Thus, higher scores were associated with less time since the last practice of the task. No other correlations of task performance with practice, months since graduation from OSUT, months since last Table VIII, or education level were significant.

In general, there was a small, positive correlation between performance and aptitude as measured by ASVAB; five tasks had significant correlations between task performance and ASVAB scores (Table 8). Load the Machinegun, Stop Tank Engine, and Gunner Prepare to Fire task scores correlated significantly with AFQT scores. Significant correlations were obtained on ASVAB composites for Load the Machinegun, Stop Tank Engine, Gunner Prepare to Fire, Precision Fire, and Radio Communication scores. Scores on Start Tank Engine, Loader Prepare to Fire, and Ground Guiding were not related to AFQT or ASVAB composites.

Task Performance in the OSUT Sample. The effects of learning, retention, education level, and AFQT were analyzed using regression analysis. A logarithmic transformation of the performance scores over trials was used to derive scores meeting the linearity assumption of the regression model. This transformation corresponds to a learning model in which errors decrease proportionately with trials, i.e.,

$$P_{n+1}(E) = (1 - k)P_n(E),$$

where $P_n(E)$ is the probability of an error on trial n , and k is the learning rate. If $P_0(C) = p$ (i.e., p is the initial probability of a correct response), then

$$P_n(C) = 1 - (1 - k)^n (1 - p).$$

Table 7

Task Performance Summary (Operational Unit)

| Task | Sample N | No. of steps | Performance on task steps | | | | |
|------------------------|-------------|-----------------|---------------------------|----------|-------------------------|--------------------|--------------------|
| | | | No. correct | | Mean percent correct | Minimum correct | Maximum correct |
| | | | Mean | St. dev. | | | |
| Load Machinegun | 116 | 11 | 9.41 | 0.76 | 86 | 6 | 11 |
| Start Tank Engine | 116 | 11 | 7.54 | 1.49 | 67 | 4 | 11 |
| Stop Tank Engine | 111 | 10 | 7.66 | 1.37 | 77 | 5 | 10 |
| Gunner Prepare to Fire | 87 | 34 | 8.06 | 4.61 | 24 | 0 | 26 |
| Loader Prepare to Fire | 107 | 6 | 3.13 | 1.69 | 52 | 0 | 6 |
| Precision Fire | 105 | 12 | 6.72 | 1.48 | 56 | 3 | 10 |
| Radio Communication | 116 | 7 | 4.94 | 1.17 | 71 | 1 | 7 |
| Ground Guiding | 116 | 20 | 19.78 | 0.48 | 99 | 18 | 20 |

Table 8

Correlations Between Task Performance and ASVAB Scores in the Operational Unit Sample

| ASVAB component | Task | | | | | | | |
|---------------------------------|------------------------------------|--------------------------|-------------------------|--|--|----------------------------------|--|----------------------------|
| | Load Machine- gun (N=107) | Start Tank (N=107) | Stop Tank (N=104) | Gunner Prepare to Fire (N=82) | Loader Prepare to Fire (N=99) | Pre- cision Fire (N=97) | Radio Communi- cation (N=107) | Ground Guide (N=107) |
| AFQT | .20* | .06 | .24* | .26* | -.07 | .17 | .09 | .02 |
| Combat | .23* | -.04 | .17 | .19 | -.05 | .17 | .10 | -.05 |
| Field Artillery | .30** | .08 | .15 | .13 | -.05 | .20* | .11 | -.04 |
| Mechanical Maintenance | .19 | .13 | .26** | .21 | -.02 | .17 | .20* | .02 |
| General Maintenance | .22* | .12 | .33** | .28* | -.06 | .28** | .21* | .05 |
| Clerical | .22* | -.06 | .04 | .07 | -.09 | .15 | .16 | -.07 |
| General Technical | .23* | .09 | .23* | .23* | -.09 | .17 | .15 | -.03 |
| Electronics Repair | .20* | .07 | .24* | .19 | -.05 | .22* | .14 | .08 |
| Surveillance/ Communications | .22* | .04 | .27** | .23* | -.02 | .20* | .19 | -.01 |
| Skilled Technical | .23* | .06 | .25* | .14 | -.10 | .24* | .17 | -.03 |
| Operators and Food Handlers | .17 | .12 | .18 | .24* | -.01 | .13 | .20 | .05 |

*p < .05.

**p < .01.

Thus, $\log [P_n(E)]$ is a linear function of n , namely:

$$\log [P_n(E)] = n \log(1 - k) + \log(1 - p).$$

The dependent variable for the learning analysis was the logarithm of the proportion of steps performed incorrectly in trials 1 to 5. The retention analysis used the proportion of steps performed correctly in trials 5 and 6 as the dependent variable. Since only two trials are used in the retention analysis, it was not necessary to transform scores to obtain linear predictions.

The effect of learning (task performance scores increasing over trials 1 to 5) was significant for all tasks, and the analysis of variance results for the effect of forgetting (task performance scores decreasing between trials 5 and 6) was significant for all tasks except Ground Guiding. These results are shown in Table 9.

Table 9

Analysis of Variance of Performance Scores over Trials in OSUT

| Task | Learning (trials 1 to 5) | | Retention (trials 5 and 6) | |
|------------------------|-----------------------------|-----------|-------------------------------|-----------|
| | <u>F</u> | <u>df</u> | <u>F</u> | <u>df</u> |
| Load Machinegun | 250.45** | 1,431 | 18.31** | 1,161 |
| Start Tank Engine | 155.65** | 1,358 | 37.72** | 1,139 |
| Stop Tank Engine | 177.27** | 1,413 | 8.85* | 1,157 |
| Gunner Prepare to Fire | 929.43** | 1,516 | 19.57** | 1,194 |
| Loader Prepare to Fire | 525.93** | 1,391 | 55.41** | 1,146 |
| Precision Fire | 148.43** | 1,351 | 45.79** | 1,135 |
| Radio Communication | 212.34** | 1,550 | 10.65* | 1,206 |
| Ground Guiding | 57.29** | 1,429 | 0.13 | 1,164 |

* $p < .01$.

** $p < .001$.

The average percentage of OSUT soldiers who performed all task steps correctly on the first trial varies from 0% (Gunner Prepare to Fire) to 31.2% (Ground Guiding). On the last learning trial (trial 5), the lowest percentage with perfect performance was 50% (Precision Fire) and the highest was 97.3% (Load Machinegun). On trial 6, administered approximately 4 weeks later, the averages varied from 10.8% (Precision Fire) to 84.8% (Ground Guiding). Results for soldiers with 100% correct performance are shown in Table 10.

Table 10

Percentage of Soldiers Performing 100% Correct (OSUT)

| Task (N) | Learning trials | | | | | Retention trial |
|------------------------------|-----------------|------|------|------|------|-----------------|
| | 1 | 2 | 3 | 4 | 5 | |
| Load Machinegun (110) | 10.9 | 80.0 | 92.7 | 90.9 | 97.3 | 75.0 |
| Start Tank Engine (93) | 11.8 | 51.6 | 71.0 | 80.6 | 94.2 | 45.5 |
| Stop Tank Engine (120) | 16.5 | 74.4 | 85.1 | 92.5 | 95.8 | 77.6 |
| Gunner Prepare to Fire (124) | 0.0 | 10.5 | 25.0 | 46.8 | 58.9 | 42.5 |
| Loader Prepare to Fire (113) | 4.4 | 43.4 | 69.0 | 91.2 | 94.6 | 47.0 |
| Precision Fire (93) | 4.7 | 26.1 | 33.3 | 51.1 | 50.0 | 10.8 |
| Radio Communication (130) | 16.2 | 34.6 | 49.2 | 60.8 | 80.8 | 65.5 |
| Ground Guiding (109) | 31.2 | 71.6 | 62.4 | 67.0 | 79.8 | 84.8 |

The average percentage of task steps performed correctly showed patterns of results similar to the percentage of soldiers performing correctly. Overall, scores on the first trial ranged from 19.7% average correct (for Loader Prepare to Fire) to 93.2% average correct (for Ground Guiding). All average scores were over 90% correct on trial 5. In the retention trial (trial 6), the lowest average percentage of correct steps was 84.4% (Precision Fire) and the highest was 99% (Ground Guiding). Results for average percent correct by task and trial are shown in Table 11.

Although a small percentage of soldiers performed entire tasks correctly, most performed substantial portions of the task correctly. For example, less than 5% of the soldiers executed the Precision Fire task correctly on the first trial, but on the average, over 66% of the steps were performed correctly. On trial 5, half of the soldiers performed the entire Precision Fire task, with 94% of the steps being performed correctly.

Both the proportion of soldiers and the average percentage of steps performed correctly returned to the level of the second trial after the retention interval (i.e., on trial 6). However, performance on three tasks, Gunner Prepare to Fire, Radio Communication, and Ground Guiding, remained higher than trial 2, and on one task (Precision Fire) performance on the sixth trial was lower than that on the second trial.

The effects of education level and AFQT were analyzed in the same regression analysis described above. The results indicate that level of education and AFQT scores were related to learning and retention for some of the tasks. AFQT scores were related to learning for two tasks: Precision Fire ($F[1,351] = 18.04, p < .001$) and Radio Communication ($F[1,550] = 25.73, p < .001$), and related to forgetting for two tasks: Gunner Prepare to Fire ($F[1,194] = 5.23, p < .05$) and Precision Fire ($F[1,135] = 9.00, p < .01$). Education level was related to learning for two tasks: Gunner Prepare to Fire ($F[1,156] = 6.05, p < .05$) and Precision Fire ($F[1,135] = 4.98, p < .05$); and to forgetting for Precision Fire ($F[1,135] = 4.93, p < .05$). Thus, for

Table 11

Percentage of Performance Measures Correct (SCUT)

| Task (N) | No. of steps | Learning trials | | | | | Retention trial |
|------------------------------|-----------------|---------------------------------------|--------------|--------------|-------------|-------------|-----------------|
| | | 1 | 2 | 3 | 4 | 5 | |
| Load Machinegun (110) | 11 | 85.9 ^a 8.5 ^b | 97.8 4.5 | 99.3 2.8 | 99.2 2.6 | 99.8 1.5 | 97.6 4.2 |
| Start Tank Engine (93) | 11 | 88.9 6.6 | 94.9 6.4 | 97.4 4.3 | 98.2 3.9 | 99.4 2.2 | 93.9 6.3 |
| Stop Tank Engine (120) | 10 | 81.5 1.5 | 97.1 5.4 | 98.6 3.5 | 99.2 2.6 | 99.6 3.0 | 97.6 6.0 |
| Gunner Prepare to Fire (124) | 34 | 33.6 23.3 | 86.0 11.8 | 93.1 7.8 | 95.8 7.7 | 98.3 2.5 | 91.8 15.9 |
| Loader Prepare to Fire (113) | 6 | 19.9 27.5 | 86.6 14.9 | 93.1 12.9 | 98.8 4.3 | 99.0 4.6 | 88.3 13.8 |
| Precision Fire (93) | 12 | 66.5 17.1 | 87.4 11.3 | 88.5 12.0 | 93.2 8.8 | 93.6 8.0 | 84.3 10.9 |
| Radio Communication (130) | 7 | 77.4 15.5 | 86.5 14.0 | 91.6 10.5 | 94.0 8.9 | 96.9 7.1 | 95.1 7.5 |
| Ground Guiding (109) | 20 ^c | 93.2 11.6 | 98.1 3.8 | 98.2 4.2 | 99.1 2.5 | 99.0 2.9 | 99.0 2.5 |

^a Mean.^b Standard deviation.^c One ground guiding course had only 19 steps.

for the Precision Fire task, AFQT and education were related to both learning and forgetting.

Analysis of Combined Operational Unit and OSUT Samples

We combined the scores from the operational unit and OSUT samples to analyze forgetting in a cross-sectional design. Since the soldiers in the OSUT research sample received training in addition to that received by the typical soldier, we corrected the retention trial scores before using them in the combined analysis. The correction was based on the distributions of the OSUT gate test results for soldiers in the research sample (who received the additional training), and for soldiers in OSUT who were not in the research (who did not receive additional training). The proportions of soldiers performing a task correctly were converted to z-scores for research and nonresearch samples. The difference between the z-scores provided a correction factor for each task in terms of the standard deviation of the test scores. Then, the correction factor was subtracted from the scores of the research soldiers on their sixth trial. However, not all tasks were tested in the OSUT gate test. For tasks not tested, the correction factor was the average of the correction factors on the tasks that were tested. Correction factors are shown in Table 12. The first column represents the correction factor in terms of the standard deviation of the scores on the retention test. The second column portrays the actual value used to adjust the proportion of correct steps; the corrected mean score is shown in the third column.

Table 12

Correction Factors for the OSUT Retention Trial

| Task | Correction factor multiple | Adjustment amount | Corrected mean (%) |
|------------------------|----------------------------------|----------------------|--------------------------|
| Load Machinegun | -.31245 | -0.013113 | 96.3 |
| Start Tank Engine | -.32075 | -0.020430 | 91.9 |
| Stop Tank Engine | -.20990 | -0.016982 | 95.9 |
| Gunner Prepare to Fire | -.22780 | -0.036873 | 88.1 |
| Loader Prepare to Fire | -.22780 | -0.031558 | 85.1 |
| Precision Fire | -.13420 | -0.0144656 | 82.9 |
| Radio Communication | -.22780 | -0.017222 | 93.4 |
| Signals | -.09160 | -0.002315 | 98.8 |

The performance scores and time since OSUT for the operational unit sample are reported in Table 7. Time since training was zero for the scores on trial 6 in the OSUT sample. Correlations between the percentage of steps passed (as corrected), and time since OSUT were significant for all tasks except Ground Guiding (Table 13).

Table 13

Correlation of Task Performance with Months Since OSUT in Combined Sample

| Task | Correlation | Number of soldiers |
|------------------------|-------------|--------------------|
| Load Machinegun | -.57* | 207 |
| Start Tank Engine | -.51* | 197 |
| Stop Tank Engine | -.52* | 212 |
| Gunner Prepare to Fire | -.68* | 187 |
| Loader Prepare to Fire | -.37* | 208 |
| Precision Fire | -.56* | 187 |
| Radio Communication | -.46* | 232 |
| Ground Guiding | -.08 | 214 |

* $p < .001$.

The slope of the retention function was used as a dependent variable in a regression analysis with task length, practice per day, complexity, and interference as independent variables. The best-fitting regression model,

$$Y = -0.000484 X_1 - 0.010449 X_2 - 0.000717 X_3 - 0.00189 X_4 + C$$

where Y = the slope of the performance retention function,

X_1 = the number of steps in the task,

X_2 = the daily practice rate,

X_3 = the complexity index score, and

X_4 = the interference index score,

accounted for 94% of the variance. Regression analysis indicated the weights of task length ($F[1,3] = 11.76$, $p < .05$), practice rate ($F[1,3] = 16.85$, $p < .05$), and interference ($F[1,3] = 13.95$, $p < .05$) were significantly greater than zero. The effect of task complexity was not significant, however ($F[1,3] = 0.93$).

Similar analyses were performed assuming exponential and power decay functions. Although the results differ in detail from those reported above, the general results were the same.

Effects of Task Length, Practice, and Interference

The effects of task length, practice, and interference on forgetting are evident for some of the tasks. This section summarizes the effects for these

variables which were significant in the regression analysis on the combined sample, although they have been tabulated separately for OSUT and unit samples elsewhere (length and task performance, Tables 7 and 12; practice, Table 6; interference, Table 5).

Task Length. The longest task, Gunner Prepare to Fire, had high scores in OSUT and the lowest scores compared to other tasks in the operational unit; thus, it had high forgetting in the combined analysis. Ground Guiding, the second longest task, did not show forgetting. This task, as tested, was composed of a series of very short subtasks. Each visual signal has only two or three steps, and thus, according to the criterion of length, each signal should be easy to remember. The natural organization of the Ground Guiding task into easily remembered signals may have facilitated performance.

Three short tasks had high scores in OSUT retention and in the operational unit (Load Machinegun, Stop Tank Engine, and Radio Communication). Another short task, Loader Prepare to Fire, had one of the lower scores in both OSUT and the unit, but did not evidence much loss of performance between the two samples.

Practice. Tasks with the highest practice ratings were Ground Guiding, which did not show performance loss, and Stop Tank Engine, which also retained high scores. Tasks with low reported practice were Precision Fire, Gunner Prepare to Fire, Loader Prepare to Fire, and Load the Machinegun. Of those with low practice, Gunner Prepare to Fire had the lowest operational unit scores. Loader Prepare to Fire and Precision Fire also had low scores in the operational unit, and thus demonstrated skill loss in the combined sample analysis.

Some steps within the tasks show effects of practice in detail. In the Start Tank Engine task, for example, the steps with high scores were the ones rated as likely to be performed in the unit under ordinary circumstances. In the Stop Tank Engine task, four steps had perfect or near perfect scores (place transmission in park, release brake pedal, hold engine fuel shut-off switch on OFF position until engine stops, and turn master battery off after engine stops) and appear to represent the way soldiers perform the task rather than the by-the-book steps.

Interference. Two of the tasks with the lowest interference, Ground Guiding and Load the Machinegun, also retain the highest performance in the operational unit. Of these, Ground Guiding is the one that showed no forgetting within the OSUT sample as well. Two tasks with high interference ratings, Start Tank Engine and Stop Tank Engine, had very high OSUT scores and moderate operational unit scores, so that they showed skill loss in the combined analysis.

While the interference ratings showed significant effects, the task characteristics that describe task complexity did not. Part of the reason may be the arbitrary nature of the composite index for complexity. For example, cues had the same weight in the composite as did other variables (since the composite was unweighted). If cues were weighted highly, the Ground Guiding tasks would have been one of the simpler tasks, rather than the most complex. Since that task was retained, the overall result in the combined sample might have shown an effect of complexity.

DISCUSSION

The present research has attempted to capture the process of skill development of Armor soldiers during OSUT and the course of their task performance capability within the first 2 years in operational Armor units. Soldiers receive formal instruction and an opportunity to practice all of the tasks they are responsible for learning in OSUT. After formal training, soldiers practice tasks informally to prepare for the gate tests they must complete to graduate. The gate test is the last time they perform any given task in OSUT. Once in an operational unit, soldiers' duty positions dictate the tasks they perform frequently. Measures of task performance obtained during OSUT and in the unit provide information on the effectiveness of formal training, the contribution of the additional preparation for tests, and the course of skill development or decay in units.

Skill Acquisition and Forgetting

The first performance measure obtained from the OSUT soldiers in the research was administered soon after they had received all the formal instruction they were to be given on a task. In some cases, such as machine gun operations, this measure came after a second formal class. OSUT task performance (Tables 10 and 11) shows that formal training was effective for most tasks, since soldiers became adept in performing most steps. The number of soldiers who could complete all performance measures was low, however, generally under 20%. The acquisition of skill progressed in typical form over the five acquisition trials, and performance improvement had generally reached high levels by the fourth trial. Performance by soldiers who had not received the additional training offered in this study was estimated from gate test scores (Table 12). This performance is superior to the initial performance after formal training, and it points out that additional training is beneficial in bringing OSUT soldiers up to their gate test performance.

After the five acquisition trials, OSUT soldiers received a sixth trial after a retention interval of 4 weeks. Forgetting was significant after this short period, but became negligible over time in the operational unit. The curve had flattened out by the third month after training, when the first substantial number of soldiers was tested in the unit. The shape of the forgetting curves (Figure 2), therefore, is the classical one that has rapid skill loss at first, and a decline of rate of loss over time, thus producing a negatively accelerating curve.

The results of the OSUT, unit, and combined samples support a contention by Rose et al. (in preparation) about the impact of time sampling along the skill retention curve. Research samples tested early in the curve, during rapid decay, show large amounts of forgetting, while samples tested later do not show decay. The data from the OSUT sample were drawn from a section of the retention curve in which decay is very rapid, and hence, significant skill loss was obtained. Data from the operational unit were sampled from an area of the curve in which forgetting is very slow.

This research supports previous findings that performance decays during the interval when soldiers transfer from school to their first unit assignments

(e.g., Osborn et al., 1978; TRASANA, 1977). Although some research has shown increments in performance after the soldier is in the unit for several months (e.g., TRASANA, 1977), the present results show neither decrements nor increments in the unit. As with prior research, the measures of practice in the unit were simply ratings by the soldier; the ratings relied on memory and have untested reliability and accuracy. Soldiers in the operational unit performed at about the same level (in percentage of steps correct) as soldiers in their initial performance after formal training. The salient task steps that soldiers learn initially are the ones they are likely to retain.

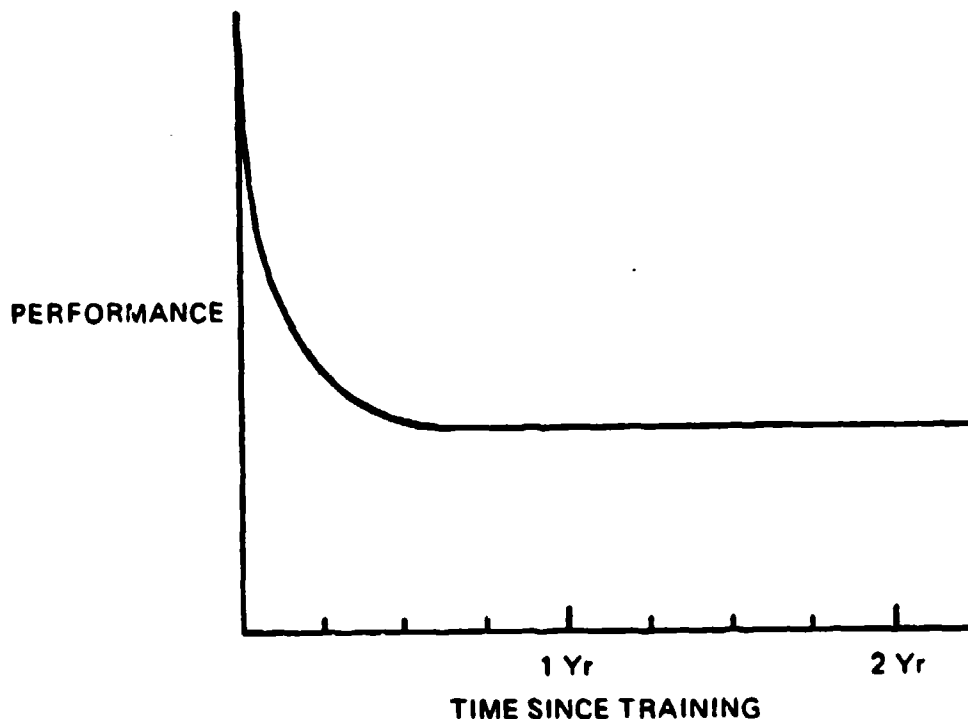


Figure 2. Hypothetical relationship between performance and time since training.

Effects of Individual Differences on Acquisition and Forgetting

Earlier ARI research showed mixed effects of aptitude on skill acquisition and retention. Results of this research showed higher retention with higher aptitude on approximately half of the tasks in the operational unit, but aptitude effects for only two tasks in the OSUT sample. Since so few tasks correlated with aptitude measures, the types of tasks or conditions under which aptitude does or does not influence acquisition and retention are unresolved.

Educational level was related to acquisition rate for only two tasks in the OSUT sample, and for only one task in the operational unit. Thus,

education did not have a strong effect in this research; this finding supports that of Goldberg et al. (1982), who found no effect from educational level. Overall, the results pertaining to aptitude and education, which were the variables investigated in the present study, corroborated previous ARI findings.

Effects of Practice, Task Length, and Interference

The effect of the extent of practice in the combined operational unit and OSUT samples indicated that practice differentiated among tasks. Tasks that were practiced more often retained high performance scores over time. One example, Ground Guiding, is a task likely to be practiced by the portion of soldiers in the operational unit who were truck drivers, as well as by the soldiers who held tank crew positions. Definitive research would need to investigate an array of common and job-specific tasks that vary systematically on the dimensions of interference, practice, and other retention variables. Alternatively, the results of the modeling in the research phases to follow this one may provide some information about retention under different conditions.

Differences among tasks in rates of forgetting were also associated with task length and interference. As demonstrated earlier by Shields, Goldberg, and Dressel (1979), tasks that are longer (have more steps) are forgotten sooner than shorter tasks. The effect of length may be the memory demand of the task. The results reported here replicate those of Shields, Goldberg, and Dressel (1979), even though the present results are based on the percentage of task steps performed correctly while those of Shields, Goldberg, and Dressel were based on the percentage of soldiers who performed the entire task correctly. Thus, even a change in the dependent variable did not degrade the effect of task length on retention.

Tasks that had more interference had higher rates of forgetting. Four sources of interference combined into the interference index were whether the step in the operational unit, as compared to the training situation, would be (1) omitted, (2) performed differently, (3) have another step substituted for it, or (4) be omitted in a similar task. Some tasks, such as Start and Stop Tank Engine, have steps that are omitted in the unit (e.g., idle the engine for a set number of minutes to cool it), and apparently these tasks are more quickly forgotten. In contrast, tasks with steps that are all performed under operational conditions, such as Load the Machinegun, are better retained. Interference theory has been cited as one of the theoretical orientations most useful in explaining forgetting (Ellis, 1979; Holding, 1965). The results of this research support that view.

Problems and Future Prospects

The results of the analysis indicate some ability to predict differences among tasks in the rate of forgetting from the number of task steps, and details about practice on the task. Given that there were only eight tasks, the ability to obtain significant results is impressive. Nevertheless, the results should not be viewed as definitive because of problems in measuring task characteristics and experience variables. Task characteristics were

measured by indices that combined several factors. With the small number of tasks used, moderate changes in the weights used to combine the factors in these indices could have a great effect on the relationship between retention and task characteristics. For example, tasks that involve greater recall from memory (a positive component of complexity) often have more and stronger performance cues (a negative component of complexity). Changes in the relative weights of these two factors in determining complexity could change the rank order of tasks on the complexity index, and hence, the overall relationship between complexity and retention.

Future research, then, should concentrate on providing refined measures of complexity, interference, and other task factors, and should relate these indices to retention on a large sample of tasks. Much of the work required is conceptual and involves the determination of appropriate factors to include in measures of complexity and interference, and proper rules for combining these factors into reliable indices. Other aspects involve increasing the sample of tasks used to test the effects of the skill components on retention.

Probably the most significant aspect of the results of the combined analysis is that it indicates that details associated with how a task is practiced influence retention. Thus, if the tasks are performed differently in the unit from the way they were trained, the soldiers' performance will look less and less like the standards set during training, and will appear to decline even at high rates of practice.

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APPENDIX A

**SAMPLE QUESTIONNAIRES
AND SCORESHEETS**

BACKGROUND INFORMATION

NAME: _____ Social Security No. _____
(Last) (First) (Middle)

PAY GRADE: E1 _____ E2 _____ E3 _____
(Check one) E4 _____ E5 _____ E6 _____

CURRENT DUTY POSITION: (1) Gunner _____ (2) Loader _____
(3) Driver _____ (4) TC _____
(5) Other _____
(Describe)

WHEN DID YOU START YOUR CURRENT DUTY POSITION? Month _____ Year _____

BATTALION: 5/33 AR _____ COMPANY: HQ _____ Platoon: 1 _____
4/37 AR _____ A _____ 2 _____
B _____ 3 _____
C _____

WHICH ENTRY LEVEL TRAINING COURSE DID YOU ATTEND?

- (1) 19E OSUT _____
(2) 19F OSUT _____
(3) Entry training in another MOS _____

WHAT OSUT TRACK DID YOU ATTEND:

- (1) Driver _____
(2) Gunner/Loader _____
(3) My OSUT did not have tracks _____

WHAT WAS YOUR OSUT COMPANY? _____

WHEN DID YOU GRADUATE FROM OSUT? Month _____ Year _____

WHEN WAS YOUR LAST TABLE 8? Month _____ Year _____
Have not participated in Table 8 _____

WHAT WAS YOUR CREW POSITION DURING YOUR LAST TABLE 8?

- (1) Tank Commander _____ (2) Gunner _____ (3) Driver _____
(4) Loader _____ (5) No Previous Table 8 _____

HOW DID YOUR CREW DO ON ITS LAST TABLE 8?

- (1) Distinguished _____ (2) Qualified _____
(2) Non-qualified _____ (4) No Previous Table 8 _____

WHAT POSITION DO YOU EXPECT TO HOLD DURING THE NEXT TABLE 8 YOUR CREW
PARTICIPATES IN?

- (1) Tank Commander _____ (2) Gunner _____
(3) Driver _____ (4) Loader _____

NAME _____
 SSAN _____
 UNIT _____

TASK-RELATED JOB EXPERIENCE

INSTRUCTIONS: Check YES if you have performed the task since you left OSUT or check NO if you have not performed it. If you check YES, please write the Date of the LAST Time that you performed it. Answer only one space under the Number of Times. For example, if you perform the task about two times a month, write 2 under the Month column.

| SINCE YOU LEFT OSUT (not counting today) HAVE YOU: | YES | NUMBER OF TIMES | | | | DATE OF LAST TIME | NO |
|---|-----|-----------------|-----------|------------|-----------|-------------------|----|
| | | a Day | a Week | a Month | a Year | | |
| 1. Loaded an M240 Coax Machinegun? | — | — | — | — | — | — | — |
| 2. Started an M60A1 Tank Engine? | — | — | — | — | — | — | — |
| 3. Stopped an M60A1 Tank Engine? | — | — | — | — | — | — | — |
| 4. Performed Gunner's Prepare-to-Fire Checks: Check Gun Controls? | — | — | — | — | — | — | — |
| 5. Performed Loader's Prepare-to-Fire Checks: Check Main Gun Firing Switches? | — | — | — | — | — | — | — |
| 6. Engaged Targets Using Precision Firing Techniques? | — | — | — | — | — | — | — |
| 7. Communicated Over Tactical Radio FM AN/VRC-64? | — | — | — | — | — | — | — |
| 8. Communicated Using Visual, Signalling Techniques: Ground Guiding? | — | — | — | — | — | — | — |

NAME _____
 SSAN _____
 UNIT _____
 TEST ☐ 1 ☐ 2 ☐ 3
 TRAIN ☐ 1 ☐ 2 ☐ 3

LOAD AN M240 COAX MACHINEGUN

INSTRUCTIONS TO SOLDIER

"At this station you will demonstrate your ability to load an M240 coaxial machinegun. Assume the machinegun will be fired immediately after it is loaded. Do you understand the instructions?" (NOTE TO SCORER: If the soldier does not, read the instructions again.) "BEGIN."

| PERFORMANCE MEASURES | YES | NO | PROMPTS | TIME |
|--|-----|-----|---------|------|
| 1. Clears the machinegun. | | | | |
| a. Pulls charger handle rearward to lock bolt back. | ___ | ___ | 1 2 3 | |
| b. Places safety on S | ___ | ___ | 1 2 3 | |
| c. Raises cover | ___ | ___ | 1 2 3 | |
| d. Lifts feedtray | ___ | ___ | 1 2 3 | |
| e. Looks and feels empty chamber. | ___ | ___ | 1 2 3 | |
| f. Lowers feedtray. | ___ | ___ | 1 2 3 | ___ |
| 2. Loads the machinegun. | | | | |
| a. Places first round in feedtray with open side of belt face down. | ___ | ___ | 1 2 3 | |
| b. Pushes ammunition in feedtray until it comes in contact with cartridge stops. | ___ | ___ | 1 2 3 | |
| c. Closes cover | ___ | ___ | 1 2 3 | |
| d. Places safety in F | ___ | ___ | 1 2 3 | |
| e. Announces "UP" when machinegun loaded. | ___ | ___ | 1 2 3 | |
| TOTAL TIME | | | | ___ |

The soldier has satisfactorily completed the task if he scores a "YES" on all of the standards listed below:

| STANDARDS | YES | NO |
|--|-----|-----|
| 1. Completes all performance measures without assistance from scorer | ___ | ___ |
| 2. Steps are performed in sequence. | ___ | ___ |
| 3. Ammunition is in feedtray and doesn't pull out when jerked. | ___ | ___ |
| TOTAL SCORE | ___ | ___ |
| TOTAL TIME | ___ | ___ |

REASON(S) FOR "NO" SCORE

NAME _____
 SSAN _____
 UNIT _____
 TEST ☐ 1 ☐ 2 ☐ 3
 TRAIN ☐ 1 ☐ 2 ☐ 3

START THE M60A1 TANK ENGINE

INSTRUCTIONS TO SOLDIER

"You are the driver of an M60A1 tank. You are to start the engine, assuming normal weather conditions. I will act as other crew positions when necessary. Do you understand the instructions?" (NOTE TO SCORER: If the soldier has questions, read the instructions again.) "BEGIN."

| PERFORMANCE MEASURES | YES | NO | PROMPTS | TIME |
|---|-----|-----|---------|------|
| 1. Sets parking brake by pushing brake pedal until pressure reaches between 750-900 psi. | ___ | ___ | 1 2 3 | |
| 2. Places transmission in PARK. | ___ | ___ | 1 2 3 | |
| 3. Releases brake pedal | ___ | ___ | 1 2 3 | |
| 4. Closes both drain valves | ___ | ___ | 1 2 3 | |
| 5. Places fuel shut-off valve handle in ON position | ___ | ___ | 1 2 3 | |
| 6. Places fuel pump switch in ON position | ___ | ___ | 1 2 3 | |
| 7. Asks crew if their electronic equipment is OFF | ___ | ___ | 1 2 3 | ___ |
| (NOTE TO SCORER: Tell soldier the electronic equipment is OFF.) | | | | |
| (NOTE TO SCORER: Insure all the electronic equipment is OFF before master battery switch is turned ON.) | | | | |
| 8. Turns master battery switch ON | ___ | ___ | 1 2 3 | |
| 9. Check fuel levels. | | | | |
| a. Sets FUEL TANKS switch to position L | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: If a soldier performs A or B, he should be given a "YES" for PM 9.) | | | | |
| 10. Depresses accelerator pedal | ___ | ___ | 1 2 3 | |
| 11. Presses starter switch until engine starts (or up to 15 seconds, whichever comes first) | ___ | ___ | 1 2 3 | ___ |

The soldier has satisfactorily completed the task if he scores a "YES" on all of the Standards listed below:

| STANDARDS | YES | NO |
|--|-----|-----|
| 1. Completes all performance measures without assistance from scorer. | ___ | ___ |
| 2. Asks if electronic equipment is OFF before turning master battery switch ON. | ___ | ___ |
| 3. Tank engine starts | ___ | ___ |
| 4. Performs performance measures in sequence when necessary (see sequence flowchart on next page). | ___ | ___ |
| TOTAL SCORE | ___ | ___ |
| TOTAL TIME | ___ | ___ |

REASON(S) FOR "NO" SCORE

NAME _____

SSAN _____

UNIT _____

TEST ☐ 1 ☐ 2 ☐ 3TRAIN ☐ 1 ☐ 2 ☐ 3

STOP THE M60A1 TANK ENGINE

INSTRUCTIONS TO SOLDIER

"You are the driver of an M60A1 tank. Assume you have driven 150 miles. You are to demonstrate the procedure for stopping the tank's engine. I will act as tank commander or gunner when necessary. Do you understand the instructions?"
 (NOTE TO SCORER: If the soldier has questions, read the instructions again.) "BEGIN."

| <u>PERFORMANCE MEASURES</u> | <u>YES</u> | <u>NO</u> | <u>PROMPTS</u> | <u>TIME</u> |
|---|------------|-----------|----------------|------------------|
| 1. Sets parking brake by pushing brake pedal until pressure reaches between 750-900 psi. | ___ | ___ | 1 2 3 | |
| 2. Places transmission in PARK. | ___ | ___ | 1 2 3 | |
| 3. Releases brake pedal | ___ | ___ | 1 2 3 | |
| 4. Presses accelerator so that engine idles at 1000-1200 rpm. (NOTE TO SCORER: Ask soldier how long engine should idle at this rpm.) | ___ | ___ | 1 2 3 | ___ |
| 5. Soldier says engine idles at 1000-1200 rpm for 5 minutes (NOTE TO SCORER: Tell soldier to continue to next step.) | ___ | ___ | 1 2 3 | |
| 6. Releases accelerator and idles engine at 700-750 rpm (NOTE TO SCORER: Ask soldier how long engine should idle at this rpm.) | ___ | ___ | 1 2 3 | |
| 7. Soldier says engine idles at 750 rpm for 3 minutes | ___ | ___ | 1 2 3 | ___ |
| 8. Asks Gunner and TC if their electronic equipment is OFF. (NOTE TO SCORER: Scorer tells soldier the equipment is OFF.) | ___ | ___ | 1 2 3 | ___ |
| 9. Holds engine fuel shut-off switch in "SHUT-OFF" (Up) until engine stops. | ___ | ___ | 1 2 3 | |
| 10. Turns master battery OFF, after engine stops | ___ | ___ | 1 2 3 | |
| | | | | TOTAL TIME _____ |

The soldier has satisfactorily completed the task if he scores a "YES" on all of the Standards listed below:

| <u>STANDARDS</u> | <u>YES</u> | <u>NO</u> |
|---|------------|-----------|
| 1. Completes all performance measures without assistance from scorer. | ___ | ___ |
| 2. Turns master battery switch OFF, after engine stops. | ___ | ___ |
| 3. Performs performance measures in sequence when required. | ___ | ___ |
| 4. Engine stops | ___ | ___ |
| TOTAL SCORE | | ___ |
| TOTAL TIME | | ___ |

REASON(S) FOR "NO" SCORE

NAME: _____
 SPAN: _____
 UNIT: _____
 TEST: ☐ 1 ☐ 2 ☐ 3
 TRAIN: ☐ 1 ☐ 2 ☐ 3

PERFORM GUNNER'S PREPARE-TO-FIRE CHECKS (CHECK GUN CONTROLS)

INSTRUCTIONS TO SOLDIER

"You are the gunner of an M60A1 tank. You are doing Prepare-to-Fire checks and have already checked the firing switches. You will perform the sequence "CHECK GUN CONTROLS" after I give you the command. The turret is in manual operation. I will act as the other crew positions when necessary. Do you understand the instructions?" (NOTE TO SCORER: If the soldier has questions, read the instructions again.) "Remember the turret must be placed into power operation before checking the azimuth indicator for accuracy or slippage." (NOTE TO SCORER: Start the training by saying "CHECK GUN CONTROL.")

PERFORMANCE MEASURES

| | YES | NO | PROMPTS | TIME |
|--|-----|-----|---------|------|
| 1. Places turret into power operation. | | | | |
| a. Holds down power solenoid plunger while rotating gunner's control handle either left or right. | ___ | ___ | 1 2 3 | |
| b. Holds gunner control handle in position described in (a) until zero pressure is indicated on pressure gage. | ___ | ___ | 1 2 3 | |
| c. Checks hydraulic power pack oil level by removing dipstick of oil level gage. | ___ | ___ | 1 2 3 | |
| d. Tells loader to unlock turret traverse lock | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Unlock turret lock.) | | | | |
| e. Announces "POWER" | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Turn on master battery switch--announce "POWER ON.") | | | | |
| f. Turns ELEV/TRAV power switch ON | ___ | ___ | 1 2 3 | |
| g. Squeezes magnetic brake switch while rotating gunner's power control handles to left and right | ___ | ___ | 1 2 3 | |
| h. Moves handles rearward to elevate gun, forward to lower gun, while squeezing magnetic brake switch | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: PM g and h may be done as listed or reversed [h then g].) | | | | |
| (NOTE TO SCORER: Tell soldier TC's power control handles have been operated.) | | | | |
| 2. Checks azimuth indicator for accuracy. | | | | |
| a. Looks through eyepiece on gunner's daylight periscope | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Tell soldier the aiming point.) | | | | |
| b. Aligns cross on aiming point using manual elevating and traversing handles. | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Verify soldier has aligned cross on aiming point.) | | | | |
| c. Sets azimuth indicator to zero. | | | | |
| - Presses resetter knob | ___ | ___ | 1 2 3 | |
| - Turns resetter knob to align middle scale pointer with inner scale pointer. | ___ | ___ | 1 2 3 | |
| - Turns resetter knob moving both pointers to zero. | ___ | ___ | 1 2 3 | |
| - Releases resetter knob. | ___ | ___ | 1 2 3 | |
| d. Traverses turret through complete circle using manual traversing handle | ___ | ___ | 1 2 3 | |
| e. Brings aiming cross back on same aiming point | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Verify the aiming cross is on original aiming point by looking through periscope.) | | | | |
| f. Turns head to check that azimuth indicator middle scale pointer is within acceptable area | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Use scoring aid when determining if the pointer is within the acceptable area.) | | | | |
| g. 1) Proceeds to next check if middle scale pointer is within acceptable area | ___ | ___ | 1 2 3 | |
| OR | | | | |
| 2) Notifies tank commander (TC) pointer is not within acceptable area | ___ | ___ | 1 2 3 | |
| 3. Checks azimuth indicator for slippage. | | | | |
| Right Side | | | | |
| a. Looks through eyepiece of gunner's daylight periscope | ___ | ___ | 1 2 3 | |
| b. Uses gunner's control handles to traverse rapidly to right. | ___ | ___ | 1 2 3 | |
| c. Stops turret suddenly while traversing. | ___ | ___ | 1 2 3 | |
| d. Turns ELEV/TRAV power switch OFF. | ___ | ___ | 1 2 3 | |
| e. Traverse turret left using manual traverse handle until cross is aligned with original aiming point | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Verify the aiming cross is on original aiming point by looking through periscope.) | | | | |
| f. Turns head to check that azimuth indicator middle scale pointer is within acceptable area | ___ | ___ | 1 2 3 | |
| (NOTE TO SCORER: Use scoring aid when determining if the pointer is within acceptable area.) | | | | |

NAME _____
 SSAN _____
 UNIT _____

TEST ☐ 1 ☐ 2 ☐ 3
 TRAIN ☐ 1 ☐ 2 ☐ 3

PERFORM GUNNER'S PREPARE-TO-FIRE CHECKS
 (CHECK GUN CONTROLS)
 (Cont'd.)

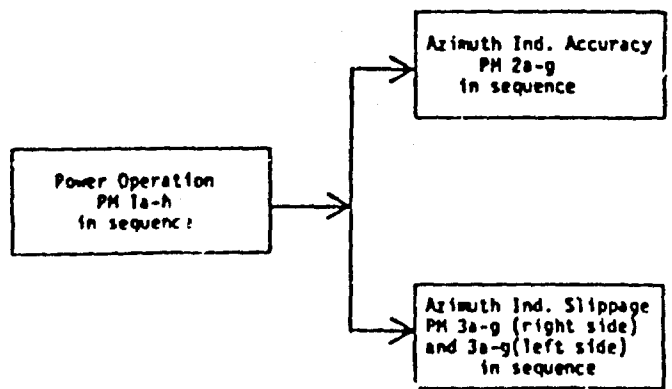
| PERFORMANCE MEASURES | YES | NO | PROMPTS | TIME |
|---|-----|----|---------|------------------|
| g. 1) Proceeds to left side check if middle scale indicator pointer is within acceptable area. | — | — | 1 2 3 | |
| OR | | | | |
| 2) Notifies TC if both pointers are not within acceptable area. | — | — | 1 2 3 | |
| h. Announces POWER. | — | — | 1 2 3 | |
| i. Turns ELEV/TRAV power switch ON. | — | — | 1 2 3 | |
| Left Side | | | | |
| a. Looks through eyepiece of gunner's daylight periscope. | — | — | 1 2 3 | |
| b. Uses gunner's control handles to traverse rapidly to left. | — | — | 1 2 3 | |
| c. Stops turret suddenly while traversing. | — | — | 1 2 3 | |
| d. Turns ELEV/TRAV power switch OFF. | — | — | 1 2 3 | |
| e. Traverses turret right using manual-traverse handle until cross is aligned with original aiming point. | — | — | 1 2 3 | |
| (NOTE TO SCORER: Verify aiming cross is on original aiming point by looking through periscope.) | | | | |
| f. Turns head to check that middle scale pointer is within acceptable area. | — | — | 1 2 3 | |
| (NOTE TO SCORER: Use scoring aid when determining if the pointers are within acceptable area.) | | | | |
| g. 1) Stops check if pointer is within acceptable area. | — | — | 1 2 3 | |
| OR | | | | |
| 2) Notifies TC if pointers are not within acceptable area. | — | — | 1 2 3 | |
| | | | | TOTAL TIME _____ |

The soldier has satisfactorily completed the task if he scores a "YES" on all of the standards listed below:

| STANDARDS | YES | NO |
|--|-----|----|
| 1. Completes all performance measures. | — | — |
| 2. Announced "POWER" before turning ELEV/TRAV switch ON. | — | — |
| 3. Pointer of azimuth indicator is within range shown on scoring aid after accuracy. | — | — |
| 4. Pointers of azimuth indicator are within range shown on scoring aid after each slippage test. | — | — |
| 5. Cross is aligned with aiming point after accuracy checks. | — | — |
| 6. Performs performance measures in sequence when necessary (see sequence flowchart below). | — | — |
| TOTAL SCORE | | — |
| TOTAL TIME | | — |

REASON(S) FOR "NO" SCORE

SEQUENCE



NAME _____
 SSAN _____
 UNIT _____
 TEST ☐ 1 ☐ 2 ☐ 3
 TRAIN ☐ 1 ☐ 2 ☐ 3

PERFORM LOADER'S PREPARE-TO-FIRE CHECKS
 (CHECK MAIN GUN FIRING SWITCHES)

INSTRUCTIONS TO SOLDIER

"You are the loader of an M60A1 tank. You are doing the Prepare-to-Fire checks and will demonstrate the section "CHECK MAIN GUN FIRING SWITCHES." I will act as the other crew positions when necessary. Do you understand the instructions?" (NOTE TO SCORER: If the soldier has questions, read the instructions again.)

(NOTE TO SCORER: Start the training trial by saying "CHECK MAIN GUN FIRING SWITCHES.")

PERFORMANCE MEASURES

| | YES | NO | PROMPTS | TIME |
|--|-----|-----|---------|------|
| 1. Closes breech by tripping extractors with block of wood. | ___ | ___ | 1 2 3 | |
| 2. Inserts circuit tester into opening between rear face of gun tube and front face of breechblock. | ___ | ___ | 1 2 3 | |
| 3. Moves main gun safety switch to FIRE position. | ___ | ___ | 1 2 3 | |
| 4. Announces "UP" | ___ | ___ | 1 2 3 | ___ |
| (NOTE TO SCORER: Turn master battery switch ON, then turn the main gun switch ON. Momentarily press the commander's control handle palm switch. Circuit tester should not light.) | | | | |
| 5. Tells gunner to squeeze main gun triggers. | ___ | ___ | 1 2 3 | ___ |
| (NOTE TO SCORER: Squeeze the trigger on each handle and the trigger on manual elevation control. Rotate the manual firing handle very rapidly in a clockwise direction. Announce ON THE WAY each time you squeeze a trigger. Circuit tester should light.) | | | | |
| 6. Tells TC to squeeze main gun trigger | ___ | ___ | 1 2 3 | ___ |
| (NOTE TO SCORER: Squeeze and hold override palm handle, then squeeze trigger. Announce "ON THE WAY." Circuit tester should light.) | | | | |
| 7. Moves main gun safety switch to SAFE | ___ | ___ | 1 2 3 | ___ |
| 8. Tells gunner to press trigger on manual firing handle. | ___ | ___ | 1 2 3 | ___ |
| (NOTE TO SCORER: Squeeze the trigger on manual firing handle. Announce "ON THE WAY." Turn manual firing handle very rapidly in clockwise direction. Announce "ON THE WAY." Circuit tester should not light.) | | | | |
| 9. Tells gunner to turn main gun OFF. | ___ | ___ | 1 2 3 | ___ |
| 10. Removes circuit tester from breechblock. | ___ | ___ | 1 2 3 | ___ |

TOTAL TIME _____

STANDARD

| | YES | NO |
|---|-----|-----|
| 1. The soldier has satisfactorily completed the task if he scores a "YES" on all of the performance measures. | ___ | ___ |
| 2. Performs performance measure in sequence when necessary (see sequence flowchart on next page). | ___ | ___ |

REASON(S) FOR "NO" SCORE

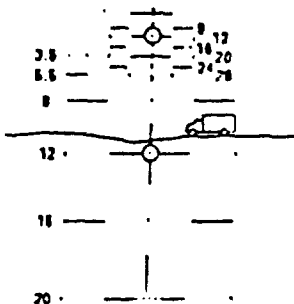
NAME _____
 SSAN _____
 UNIT _____

PL. 11.

SERIES 2

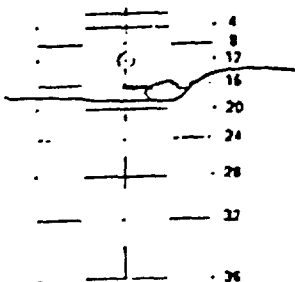
Engagement 1
 (Periscope damaged)
 Gunner
 HEP
 Moving Truck
 1000

- | | Yes | No | Prompts | | | Time |
|---|-----|----|---------|---|---|------|
| | | | 1 | 2 | 3 | |
| 1. Turns main gun switch ON | | | 1 | 2 | 3 | |
| 2. Indexes ammunition | | | 1 | 2 | 3 | |
| 3. Announces IDENTIFIED | | | 1 | 2 | 3 | |
| NOTE: Scorer says UP | | | | | | |
| NOTE: Scorer says FIRE | | | | | | |
| 4. Looks through correct sight | | | 1 | 2 | 3 | |
| Periscope | | | | | | |
| Telescope <u>✓</u> | | | | | | |
| 5. Selects correct reticle | | | 1 | 2 | 3 | |
| Periscope | | | | | | |
| SABOT/HEP <u>✓</u> | | | | | | |
| HEAT | | | | | | |
| 6. Lays crosshair at center of the target (with lead applied). | | | 1 | 2 | 3 | |
| Periscope crosshair | | | | | | |
| SABOT 2000M range line, 2.5 mil lead | | | | | | |
| HEP 1000M range line, 7.5 mil lead <u>✓</u> | | | | | | |
| HEAT 1800M range line, 5.0 mil lead | | | | | | |
| 7. Says ON THE WAY. | | | 1 | 2 | 3 | |



Engagement 2
 (Periscope damaged)
 Gunner
 HEAT
 Moving Tank
 1800

- | | Yes | No | Prompts | | | Time |
|---|-----|----|---------|---|---|------|
| | | | 1 | 2 | 3 | |
| 1. Turns main gun switch ON | | | 1 | 2 | 3 | |
| 2. Indexes ammunition | | | 1 | 2 | 3 | |
| 3. Announces IDENTIFIED | | | 1 | 2 | 3 | |
| NOTE: Scorer says UP | | | | | | |
| NOTE: Scorer says FIRE | | | | | | |
| 4. Looks through correct sight | | | 1 | 2 | 3 | |
| Periscope | | | | | | |
| Telescope <u>✓</u> | | | | | | |
| 5. Selects correct reticle | | | 1 | 2 | 3 | |
| Periscope | | | | | | |
| SABOT/HEP | | | | | | |
| HEAT <u>✓</u> | | | | | | |
| 6. Lays crosshair at center of the target (with lead applied). | | | 1 | 2 | 3 | |
| Periscope crosshair | | | | | | |
| SABOT 2000M range line, 2.5 mil lead | | | | | | |
| HEP 1000M range line, 7.5 mil lead | | | | | | |
| HEAT 1800M range line, 5.0 mil lead <u>✓</u> | | | | | | |
| 7. Says ON THE WAY. | | | 1 | 2 | 3 | |



NAME _____
 SSAN _____
 UNIT _____

SERIES 2

Prompts

1 2 3 Time

Yes No

1 2 3

1 2 3

1 2 3

1 2 3

1 2 3

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Engagement 3

(Periscope damaged)

Gunner

SABOT

Moving Tank

2000

1. Turns main gun switch ON

2. Indexes ammunition

3. Announces IDENTIFIED

NOTE: Scorer says UF

NOTE: Scorer says FIRE

4. Looks through correct sight

Periscope

Telescope

5. Selects correct reticle

Periscope

SABOT/HEP

HEAT

6. Lays crosshair at center of the target

(with lead applied)

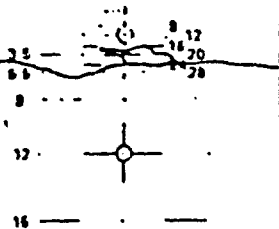
Periscope crosshair

SABOT 2000M range line, 2.5 mil lead

HEP 1000M range line, 7.5 mil lead

HEAT 1800M range line, 5.0 mil lead

7. Says ON THE WAY



Engagement 4

Gunner

HEP

Truck

1. Turns main gun switch ON

2. Indexes ammunition

3. Announces IDENTIFIED

NOTE: Scorer says UF

NOTE: Scorer says FIRE

4. Looks through correct sight

Periscope

Telescope

5. Selects correct reticle

Periscope

SABOT/HEP

HEAT

6. Lays crosshair at center of the target

(with lead applied)

Periscope crosshair

SABOT 2000M range line, 2.5 mil lead

HEP 1000M range line, 7.5 mil lead

HEAT 1800M range line, 5.0 mil lead

7. Says ON THE WAY



NAME _____

SSAN _____

UNIT _____

TEST ☐ 1 ☐ 2 ☐ 3

TRAIN ☐ 1 ☐ 2 ☐ 3

COMMUNICATE OVER TACTICAL FM RADIO AN/VRC-64

| <u>PERFORMANCE MEASURES</u> | <u>YES</u> | <u>NO</u> | <u>PROMPTS</u> | <u>TIME</u> |
|--|------------|-----------|----------------|-------------|
| 1. Places CVC helmet switch in center position. | ___ | ___ | 1 2 3 | |
| 2. Calls net control station. | ___ | ___ | 1 2 3 | |
| 3. Identifies himself before giving the messages. | ___ | ___ | 1 2 3 | |
| 4. Tells net control station number of messages. | ___ | ___ | 1 2 3 | |
| 5. Tells net control station precedence of messages. | ___ | ___ | 1 2 3 | |
| 6. Transmits Message. | ___ | ___ | 1 2 3 | ___ |
| 7. Uses phonetic alphabet as required | ___ | ___ | 1 2 3 | |
| 8. Pronounces numbers correctly | ___ | ___ | 1 2 3 | |
| 9. Says OVER after Message. | ___ | ___ | 1 2 3 | ___ |

| <u>STANDARDS</u> | <u>YES</u> | <u>NO</u> |
|---|------------|-----------|
| 1. Each performance measure completed with a YES. | ___ | ___ |
| 2. Steps are performed in sequence. | ___ | ___ |
| TOTAL TIME | ___ | ___ |

INSTRUCTIONS TO SOLDIER

"At this station you will demonstrate your ability to communicate a message over a tactical FM radio AN/VRC-64. I will be the net control station. Here is the information you need to transmit the message." (NOTE TO SCORER: Hand soldier the attachment, a pencil and a sheet of paper.) "You will have two minutes to review the attachment before we begin. Do you understand the instructions?" (NOTE TO SCORER: If the soldier does not understand the instructions, reread them.) "You may review the message information now."

COURSE 2

NAME _____
 SSAN _____
 UNIT _____
 TEST ☐ 1 ☐ 2 ☐ 3
 TRAIN ☐ 1 ☐ 2 ☐ 3

COMMUNICATE USING VISUAL SIGNALLING TECHNIQUES: GROUND GUIDING

INSTRUCTIONS TO SOLDIER

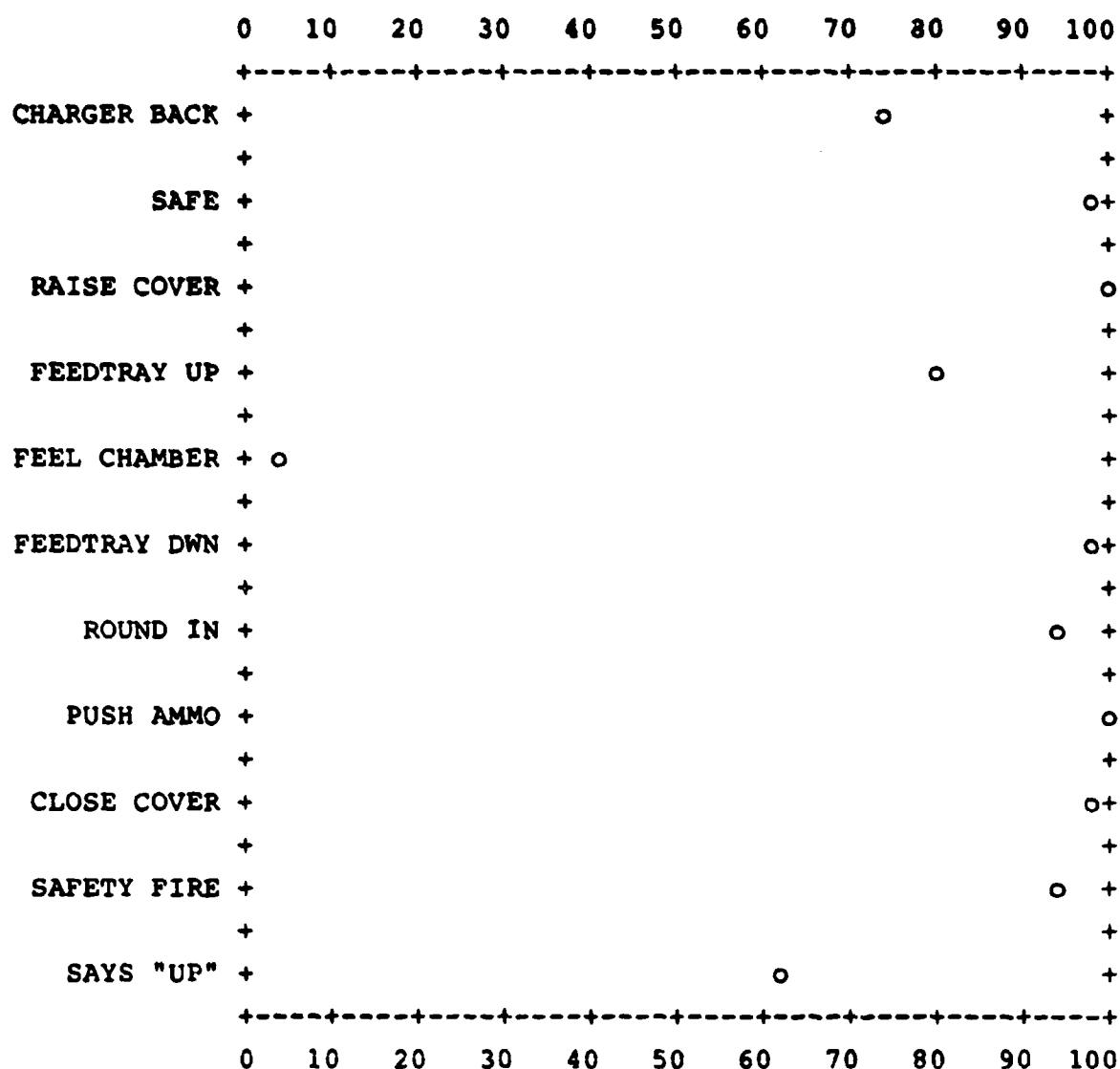
"At this station you will be tested on your ability to ground guide a tank from the START point to the FINISH point of a driving course. The course is clearly marked for you. I will be the tank; whatever direction I am facing will be the direction the tank is facing. I am parked in the motor pool. My engine is not running. When we get to the FINISH point, assume that I won't be moving anymore today. Do you understand the instructions?" (NOTE TO SCORER: If soldier does not understand the instructions, reread them.) "BEGIN."

| PERFORMANCE MEASURES | YES | NO | PROMPTS | TIME | SIGNAL GIVEN |
|---|-----|----|---------|------|--------------|
| 1. Gives signal to Start Engine. | | | | | |
| a. Extends arm toward front at waist level. | — | — | 1 2 3 | | |
| b. Moves arm in circular motion | — | — | 1 2 3 | | |
| 2. Gives signal to Move in Reverse. | | | | | |
| a. Raises both hands to shoulder level. | — | — | 1 2 3 | | |
| b. Places palms to front. | — | — | 1 2 3 | | |
| c. Moves hands forward and backward as if pushing vehicle away. | — | — | 1 2 3 | | |
| 3. Gives signal to Stop Tank Movement. | | | | | |
| a. Clasps hands | — | — | 1 2 3 | | |
| b. Places hands at chin level | — | — | 1 2 3 | | |
| 4. Gives signal to Move Vehicle Forward. | | | | | |
| a. Positions both palms toward chest. | — | — | 1 2 3 | | |
| b. Moves arms and hands backward and forward. | — | — | 1 2 3 | | |
| 5. Gives signal to Turn Left. | | | | | |
| a. Raises hands to shoulder level in front of body. | — | — | 1 2 3 | | |
| b. Forms clenched fist of arm indicating direction turn is to be made (as seen by tank driver). | — | — | 1 2 3 | | |
| c. Makes beckoning motion with other arm to bring vehicle forward | — | — | 1 2 3 | | |
| 6. Gives signal to Move Vehicle Forward. | | | | | |
| a. Positions both palms toward chest. | — | — | 1 2 3 | | |
| b. Moves arms and hands backward and forward. | — | — | 1 2 3 | | |
| 7. Gives signal to Stop Tank Movement. | | | | | |
| a. Clasps hands | — | — | 1 2 3 | | |
| b. Places hands at chin level | — | — | 1 2 3 | | |
| 8. Gives signal to Steer Neutral (Left). | | | | | |
| a. Crosses wrists at throat | — | — | 1 2 3 | | |
| b. Points index finger to tank driver's left. | — | — | 1 2 3 | | |
| c. Clenches fist of other hand. | — | — | 1 2 3 | | |
| NOTE: If soldier gives left turn signal, tell him to give the signal for neutral steer left. Do not mark the PM "NO." | | | | | |
| 9. Gives signal to Move Vehicle Forward. | | | | | |
| a. Positions both palms toward chest. | — | — | 1 2 3 | | |
| b. Moves arms and hands backward and forward. | — | — | 1 2 3 | | |
| 10. Gives signal to Turn Right. | | | | | |
| a. Raises hands to shoulder level in front of body. | — | — | 1 2 3 | | |
| b. Forms clenched fist of arm indicating direction turn is to be made (as seen by tank driver). | — | — | 1 2 3 | | |
| c. Makes beckoning motion with other arm to bring vehicle forward | — | — | 1 2 3 | | |
| 11. Gives signal to Move Vehicle Forward. | | | | | |
| a. Positions both palms toward chest. | — | — | 1 2 3 | | |
| b. Moves arms and hands backward and forward. | — | — | 1 2 3 | | |
| 12. Gives signal to Stop Tank Movement. | | | | | |
| a. Clasps hands | — | — | 1 2 3 | | |
| b. Places hands at chin level | — | — | 1 2 3 | | |
| 13. Gives signal to Stop Engines. | | | | | |
| a. Positions right hand palm down | — | — | 1 2 3 | | |
| b. Draws hand across neck in "throat cutting" motion from left to right. | — | — | 1 2 3 | | |
| STANDARD | YES | NO | | | |
| 1. Completes each performance measure without assistance from scorer. | — | — | | | |
| 2. Ground guide signals given in sequence indicated | — | — | | | |
| 3. Correct ground guide signal given. | — | — | | | |
| TOTAL TIME | | | | | |

REASON(S) FOR "NO" SCORE

APPENDIX B

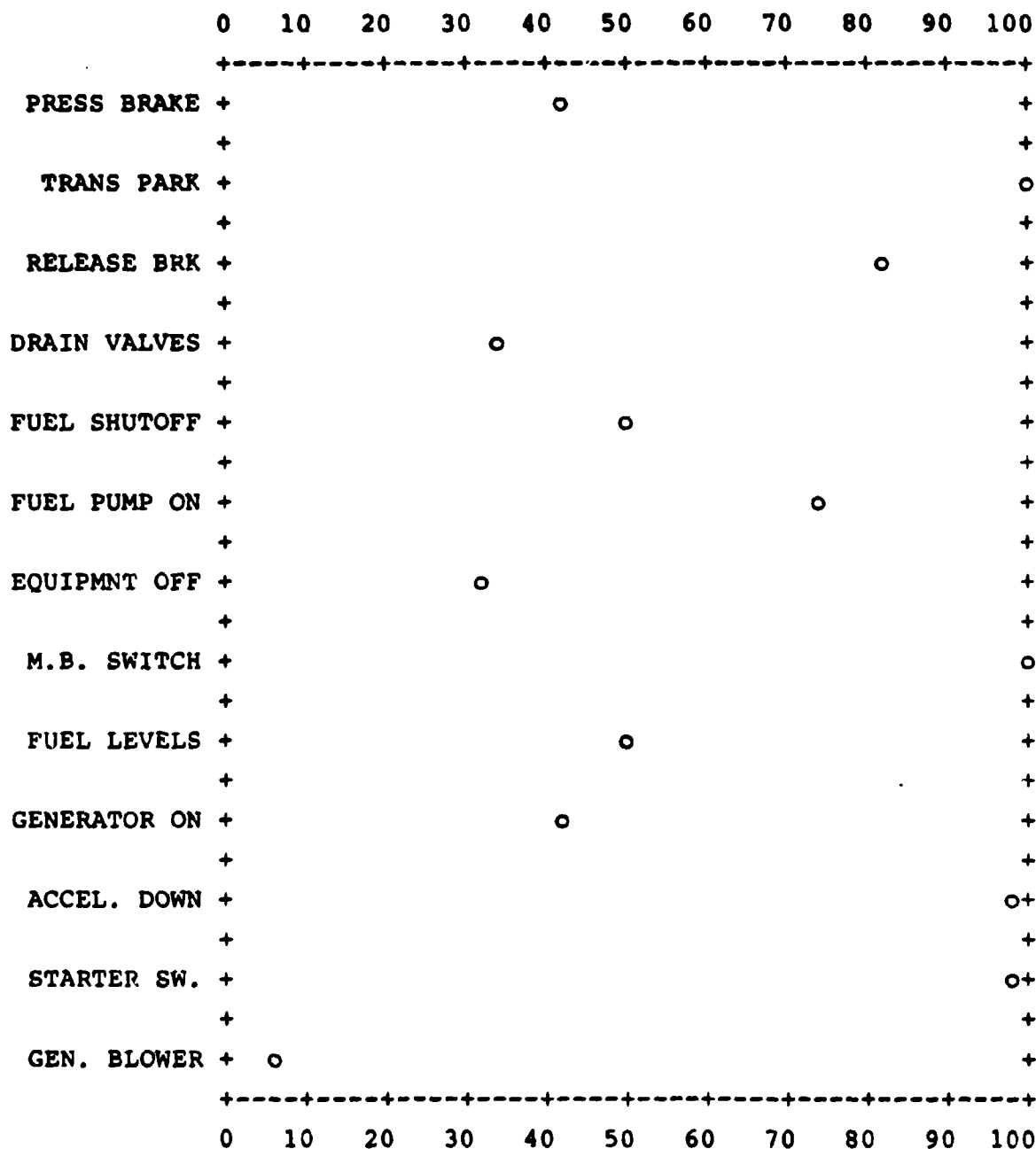
**PROPORTION CORRECT BY TASK ELEMENT FOR OSUT
AND OPERATIONAL UNIT SAMPLES**



LOAD THE M240 MACHINEGUN
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Charger Back | 96 | 100 | 100 | 100 | 100 | 100 |
| Safe | 99 | 100 | 100 | 100 | 100 | 100 |
| Raise Cover | 85 | 93 | 95 | 95 | 100 | 88 |
| Feedtray Up | 100 | 100 | 100 | 100 | 100 | 100 |
| Feel Chamber | 57 | 98 | 99 | 100 | 100 | 95 |
| Feedtray Down | 98 | 100 | 99 | 100 | 100 | 100 |
| Round In | 100 | 99 | 99 | 100 | 100 | 100 |
| Close Cover | 100 | 100 | 100 | 99 | 100 | 100 |
| Safety Fire | 68 | 98 | 100 | 99 | 99 | 100 |
| Says "Up" | 41 | 88 | 99 | 98 | 100 | 92 |

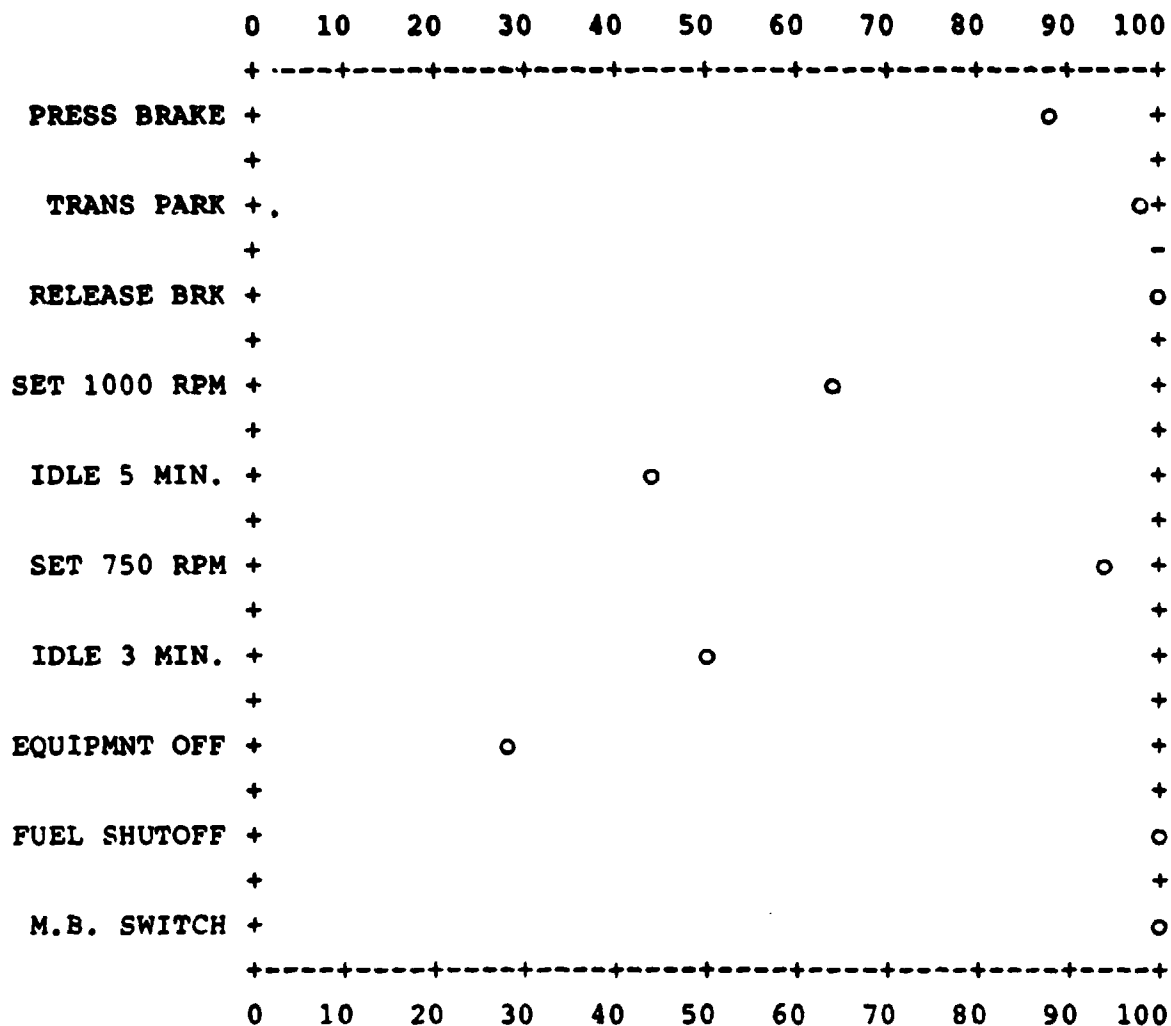
LOAD THE M240 MACHINEGUN PROPORTION
CORRECT BY TASK ELEMENT IN OSUT (N=110)



START THE M60A1 TANK ENGINE
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Press Brake | 98 | 100 | 100 | 100 | 100 | 100 |
| Trans. Park | 99 | 100 | 99 | 99 | 99 | 100 |
| Release Brake | 93 | 98 | 98 | 99 | 100 | 99 |
| Drain Valves | 90 | 94 | 100 | 100 | 100 | 99 |
| Fuel Shutoff | 99 | 100 | 100 | 100 | 100 | 100 |
| Fuel Pump On | 100 | 100 | 100 | 100 | 100 | 98 |
| Equipment Off | 89 | 99 | 98 | 99 | 100 | 99 |
| M. B. Switch | 39 | 74 | 89 | 93 | 100 | 62 |
| Fuel Levels | 96 | 99 | 98 | 100 | 99 | 95 |
| Accl. Down | 86 | 89 | 93 | 92 | 97 | 90 |
| Starter | 91 | 91 | 96 | 98 | 99 | 91 |

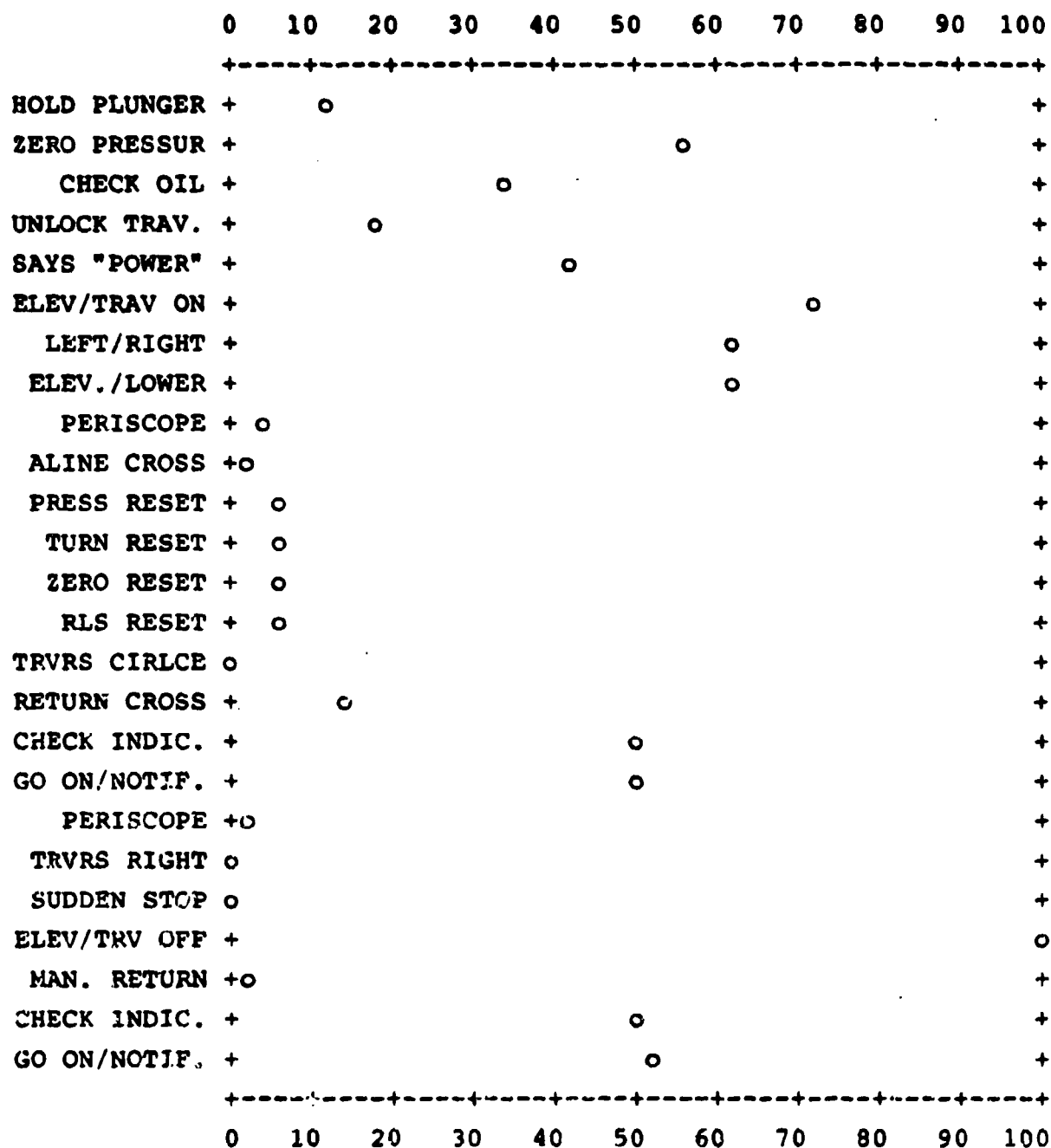
START THE M60A1 TANK ENGINE
PROPORTION CORRECT BY TASK ELEMENT IN OSUT (N=93)



STOP THE M60A1 TANK ENGINE
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N-116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Press Brake | 97 | 100 | 100 | 100 | 100 | 100 |
| Trans. Park | 97 | 99 | 100 | 100 | 100 | 100 |
| Release Brake | 97 | 97 | 98 | 99 | 98 | 100 |
| Set 1000 RPM | 81 | 97 | 98 | 98 | 99 | 97 |
| Idle 5 minutes | 62 | 97 | 100 | 100 | 99 | 94 |
| Set 750 RPM | 95 | 99 | 100 | 100 | 100 | 99 |
| Idle 3 minutes | 78 | 97 | 99 | 100 | 100 | 95 |
| Equipment Off | 92 | 99 | 100 | 99 | 100 | 100 |
| Fuel Shut-Off | 57 | 92 | 95 | 98 | 99 | 94 |
| MB Switch | 60 | 93 | 95 | 98 | 100 | 95 |

TOP THE M60A1 ENGINE
PROPORTION CORRECT BY TASK ELEMENT IN OSUT (N=120)



PERFORM GUNNER'S PREPARE-TO-FIRE CHECKS
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|------------------|---|----|----|----|----|----|----|----|----|----|-----|
| | + | + | + | + | + | + | + | + | + | + | + |
| SAY "POWER" + | | | | | | | | | | | o |
| ELEV/TRAV ON + | | o | | | | | | | | | + |
| PERISCOPE o | | | | | | | | | | | + |
| TRVRS LEFT +o | | | | | | | | | | | + |
| SUDDEN STOP + o | | | | | | | | | | | + |
| ELEV/TRV OFF + o | | | | | | | | | | | + |
| MAN. RETURN + o | | | | | | | | | | | + |
| CHECK INDIC. + | | | | | | | | o | | | + |
| STOP/NOTIF. + | | | | | | | | o | | | + |
| | + | + | + | + | + | + | + | + | + | + | + |
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

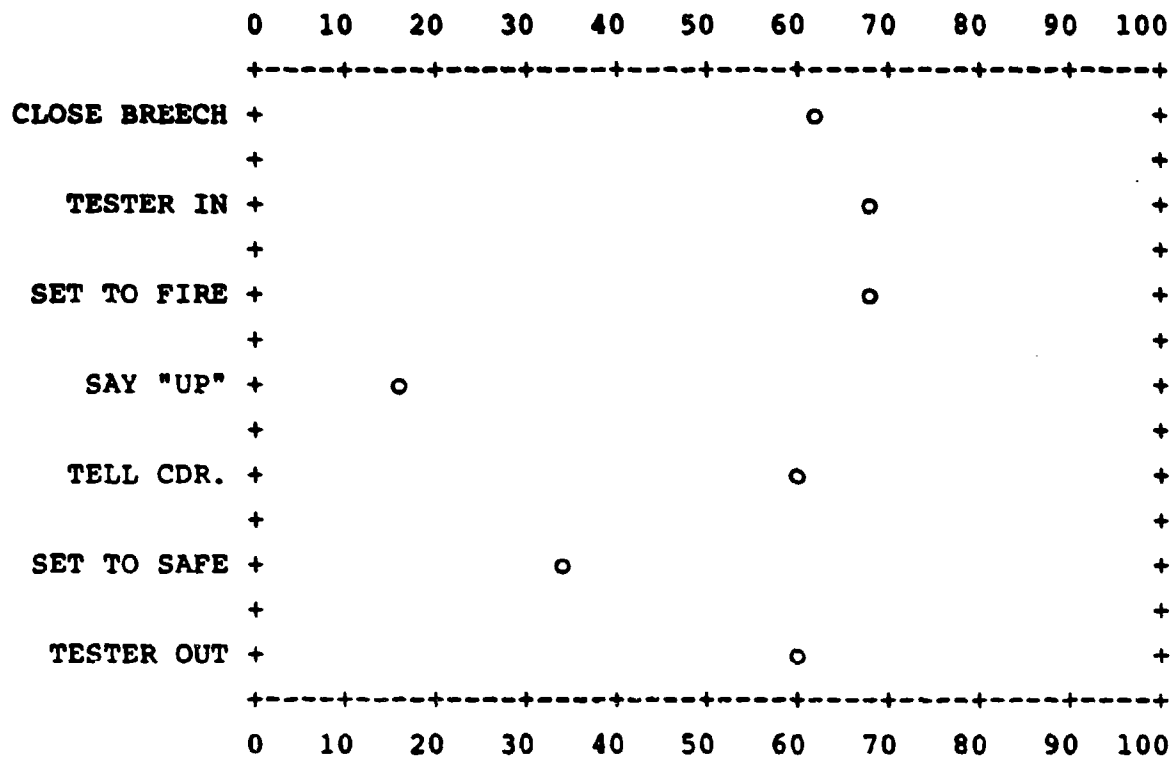
PERFORM GUNNER PREPARE-TO-FIRE CHECKS
PROPORTION CORRECT BY TASK ELEMENT
IN OPERATIONAL UNIT (N-116)
(CONTINUED)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Hold Plunger | 19 | 84 | 97 | 99 | 100 | 87 |
| Zero Pressure | 40 | 94 | 100 | 100 | 100 | 94 |
| Check Oil | 35 | 93 | 95 | 98 | 100 | 97 |
| Unlock Trav. | 7 | 72 | 90 | 96 | 99 | 86 |
| Say "Power" | 22 | 66 | 80 | 90 | 94 | 79 |
| Elev/Trav on | 36 | 92 | 93 | 99 | 99 | 96 |
| Left/Right | 27 | 76 | 89 | 92 | 97 | 85 |
| Elev/Lower | 32 | 80 | 91 | 95 | 98 | 93 |
| Periscope | 15 | 77 | 86 | 94 | 98 | 90 |
| Aline Cross | 23 | 68 | 83 | 89 | 93 | 75 |
| Press Reset | 8 | 90 | 90 | 90 | 95 | 87 |
| Turn Reset | 11 | 98 | 99 | 99 | 100 | 96 |
| Zero Reset | 11 | 98 | 99 | 99 | 100 | 96 |
| Rls Reset | 30 | 99 | 99 | 99 | 99 | 94 |
| Trus Circle | 11 | 54 | 68 | 81 | 90 | 77 |
| Return Cross | 31 | 98 | 99 | 99 | 100 | 96 |
| Check Indic | 29 | 93 | 98 | 98 | 100 | 95 |
| Go On/Notif. | 46 | 98 | 99 | 98 | 100 | 97 |
| Periscope | 5 | 84 | 93 | 96 | 100 | 91 |
| Trus Right | 2 | 81 | 91 | 95 | 99 | 90 |
| Sudden Stop | 4 | 88 | 94 | 98 | 100 | 92 |
| Elev/Trv Off | 5 | 69 | 82 | 90 | 96 | 92 |
| Manual Return | 20 | 58 | 76 | 89 | 93 | 82 |
| Check Indic | 42 | 95 | 98 | 98 | 100 | 94 |
| Go On/Notif. | 45 | 92 | 98 | 98 | 99 | 96 |
| Say "Power" | 51 | 85 | 94 | 93 | 98 | 95 |
| Elev/Trav On | 63 | 90 | 96 | 98 | 99 | 97 |
| Periscope | 67 | 94 | 99 | 98 | 99 | 97 |

GUNNER PERPARE TO FIRE PROPORTION
CORRECT BY TASK ELEMENT IN OSUT (N=114)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| TRVS Left | 70 | 93 | 99 | 98 | 100 | 96 |
| Sudden Stop | 72 | 94 | 99 | 98 | 99 | 97 |
| Elev/Trv Off | 67 | 92 | 95 | 96 | 99 | 96 |
| Manual Return | 58 | 87 | 96 | 97 | 96 | 92 |
| Check Indic. | 74 | 96 | 98 | 98 | 100 | 93 |
| Stop/Notif. | 80 | 96 | 99 | 98 | 100 | 95 |

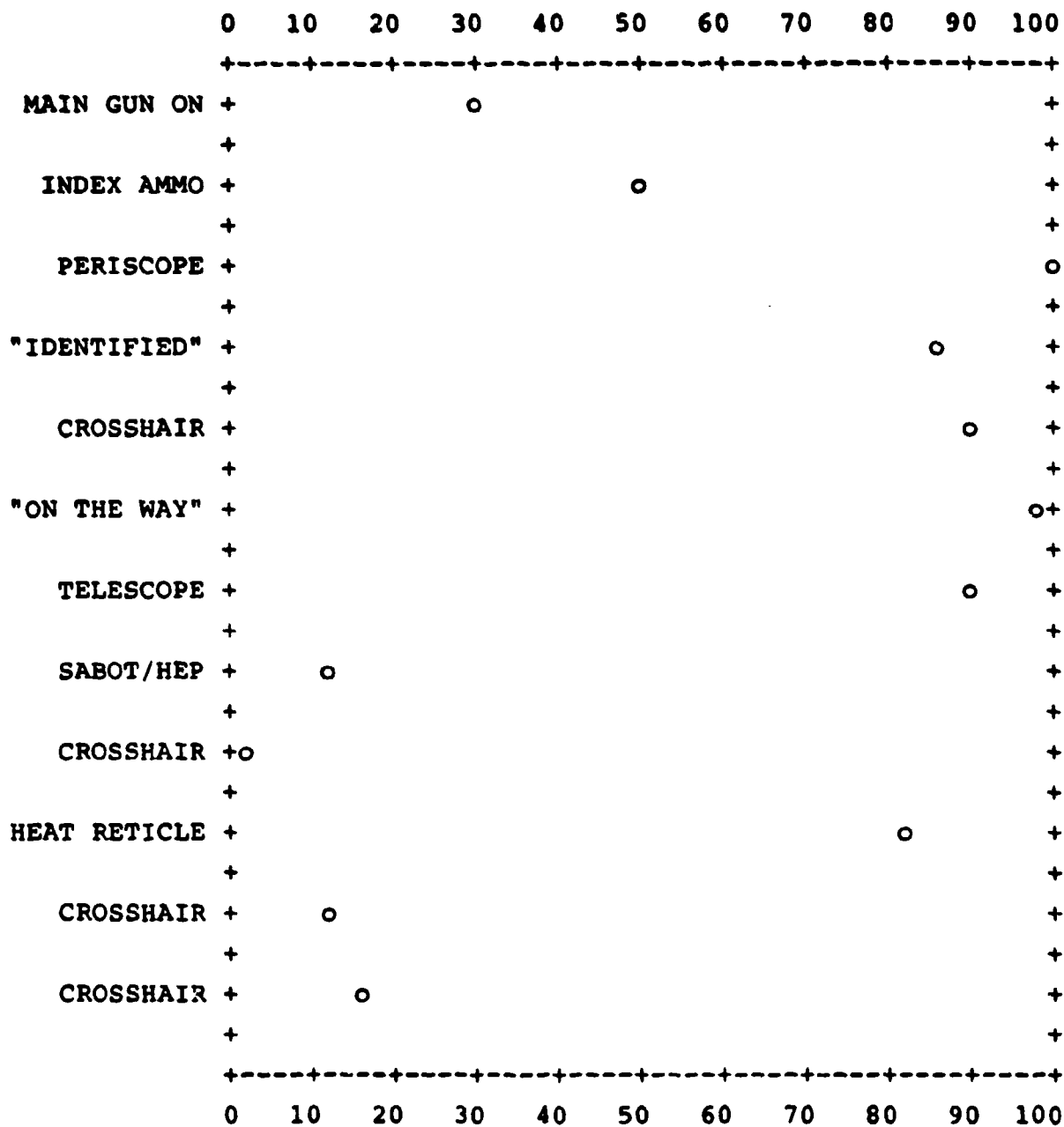
GUNNER PREPARE TO FIRE PROPORTION
CORRECT BY TASK ELEMENT IN OSUT (N=114)
(CONTINUED)



PERFORM LOADER'S PREPARE-TO-FIRE CHECKS
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Close Breech | 17 | 100 | 100 | 100 | 100 | 97 |
| Tester In | 22 | 98 | 96 | 98 | 100 | 95 |
| Set to Fire | 17 | 80 | 90 | 99 | 99 | 86 |
| Say "Up" | 26 | 81 | 91 | 97 | 99 | 91 |
| Set to Safe | 17 | 95 | 96 | 100 | 100 | 90 |
| Tester Out | 21 | 65 | 84 | 98 | 96 | 70 |

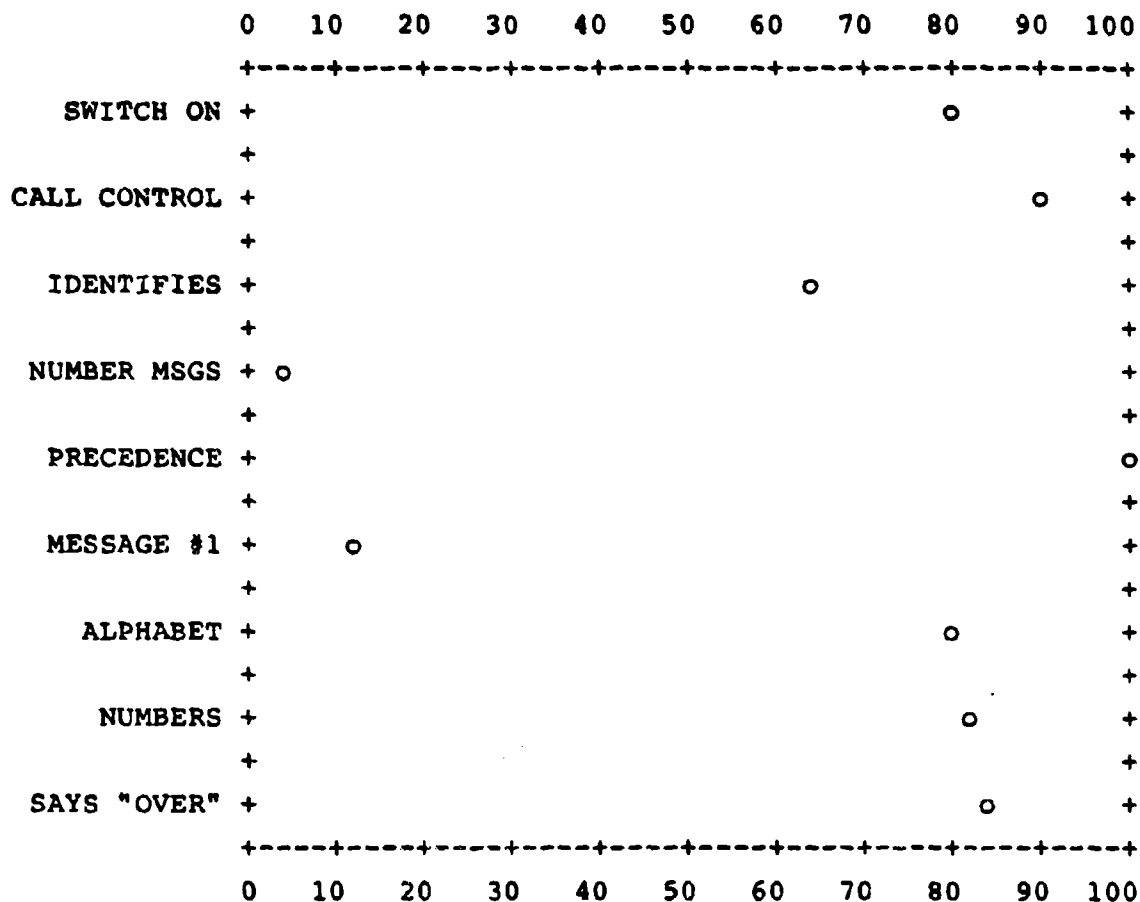
PERFORM LOADER'S PREPARE-TO-FIRE CHECKS
 PROPORTION CORRECT BY TASK ELEMENT IN OSUT (N=113)



ENGAGE TARGETS USING PRECISION FIRE TECHNIQUES
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Main Gun On | 83 | 96 | 98 | 98 | 99 | 96 |
| Index Ammo | 84 | 99 | 99 | 99 | 99 | 98 |
| Periscope | 86 | 100 | 97 | 99 | 98 | 99 |
| "Identified" | 77 | 99 | 96 | 99 | 99 | 98 |
| Crosshair | 19 | 73 | 94 | 86 | 97 | 29 |
| "On the Way" | 43 | 91 | 94 | 97 | 98 | 87 |
| Telescope | 97 | 98 | 99 | 100 | 99 | 100 |
| SABOT/HEP | 66 | 90 | 86 | 98 | 98 | 92 |
| Crosshair | 29 | 51 | 67 | 80 | 76 | 65 |
| HEAT Reticle | 87 | 100 | 96 | 100 | 99 | 89 |
| Crosshair | 79 | 95 | 81 | 92 | 81 | 68 |
| Crosshair | 32 | 60 | 57 | 71 | 82 | 93 |

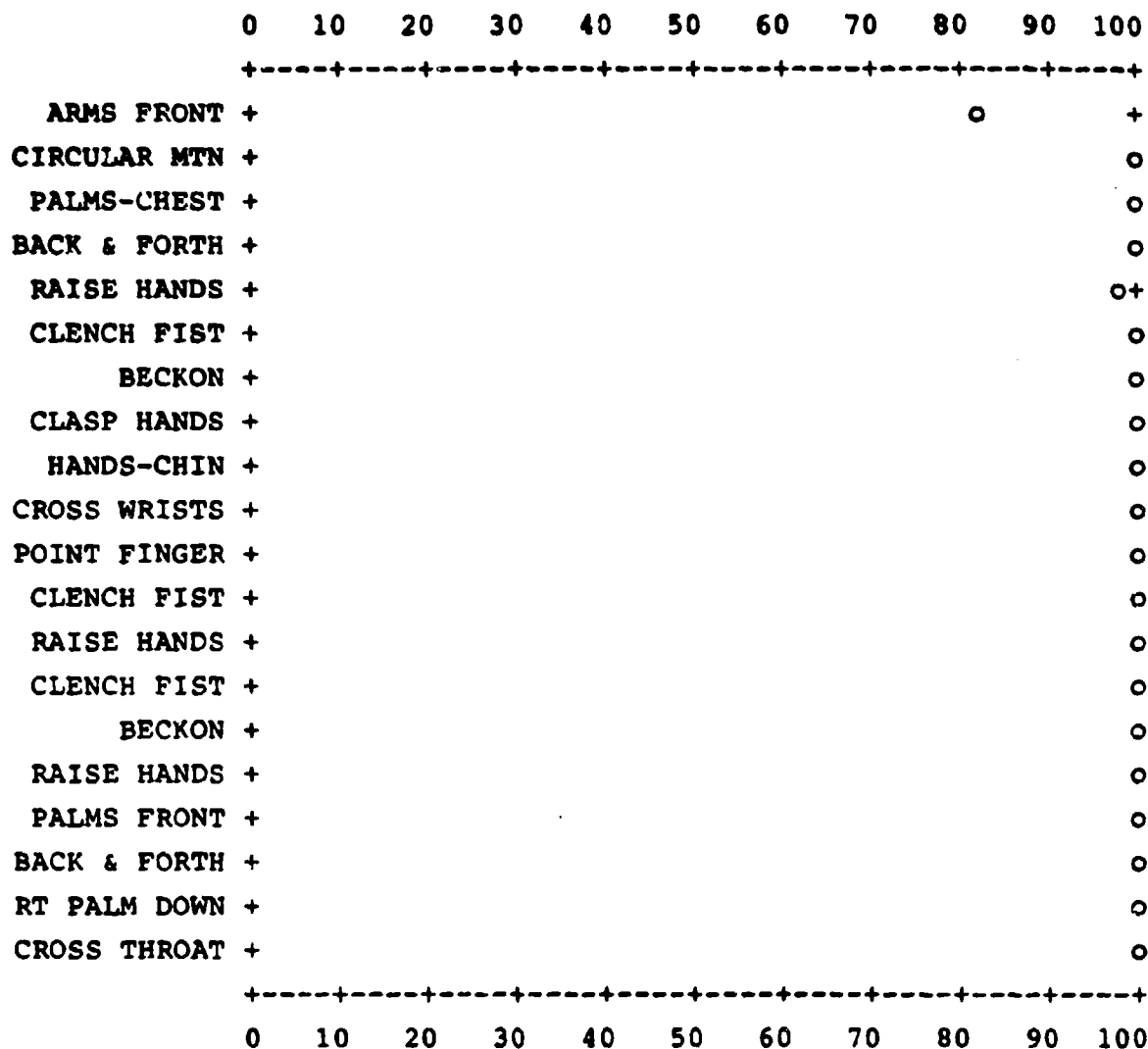
ENGAGE TARGETS USING PRECISION FIRE
TECHNIQUES PROPORTION CORRECT BY TASK
ELEMENTS IN OSUT (N=93)



COMMUNICATE OVER TACTICAL RM RADIO AN/VRC-64
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| Switch On | 87 | 100 | 99 | 98 | 100 | 96 |
| Call Control | 77 | 90 | 90 | 98 | 98 | 99 |
| Identifies | 92 | 93 | 98 | 98 | 99 | 99 |
| No. Messenger | 69 | 94 | 94 | 90 | 95 | 100 |
| Precedence | 41 | 61 | 75 | 87 | 92 | 71 |
| Message #1 | 45 | 66 | 83 | 92 | 94 | 97 |
| Alphabet | 67 | 79 | 83 | 78 | 96 | 83 |
| Numbers | 78 | 78 | 90 | 92 | 91 | 92 |
| Says "Over" | 97 | 98 | 98 | 100 | 100 | 100 |

COMMUNICATE OVER TACTICAL FM RADIO AN/VRC-64
PROPORTION CORRECT BY TASK ELEMENT IN OSUT (N=130)



COMMUNICATE USING VISUAL SIGNALLING TECHNIQUES
 PROPORTION CORRECT BY TASK ELEMENT
 IN OPERATIONAL UNIT (N=116)

| <u>Task Element</u> | <u>Trials</u> | | | | | |
|---------------------|---------------|----------|----------|----------|----------|----------|
| | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> |
| ARMS FRONT | 93 | 97 | 97 | 99 | 99 | 100 |
| CIRCULAR MTN | 98 | 98 | 98 | 99 | 100 | 100 |
| PALMS-CHEST | 93 | 100 | 99 | 100 | 99 | 100 |
| BACK & FORTH | 95 | 100 | 98 | 100 | 99 | 100 |
| RAISE HANDS | 88 | 96 | 97 | 99 | 100 | 97 |
| CLENCH FIST | 90 | 93 | 91 | 94 | 94 | 98 |
| BECKON | 97 | 99 | 98 | 99 | 100 | 99 |
| CLASP HANDS | 90 | 98 | 99 | 99 | 98 | 98 |
| HANDS-CHIN | 94 | 100 | 100 | 99 | 100 | 97 |
| CROSS WRISTS | 78 | 96 | 95 | 98 | 97 | 99 |
| POINT FINGER | 90 | 94 | 97 | 98 | 97 | 95 |
| CLENCH FIST | 94 | 100 | 100 | 100 | 97 | 100 |
| RAISE HANDS | 94 | 97 | 98 | 99 | 100 | 97 |
| CLENCH FIST | 89 | 95 | 98 | 97 | 99 | 98 |
| BECKON | 97 | 99 | 98 | 100 | 100 | 99 |
| RAISE HANDS | 95 | 99 | 100 | 100 | 100 | 99 |
| PALMS FRONT | 97 | 100 | 100 | 100 | 100 | 100 |
| BACK & FORTH | 96 | 100 | 100 | 100 | 99 | 100 |
| RT PALM DOWN | 96 | 100 | 99 | 100 | 100 | 100 |
| CROSS THROAT | 99 | 100 | 100 | 100 | 100 | 100 |

COMMUNICATE USING VISUAL SIGNALLING TECHNIQUES
 PROPORTION CORRECT BY TASK ELEMENT
 IN OSUT (N=109)